QRPp

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From the Editor
by Doug Hendricks, KI6DS
862 Frank Ave.
Dos Palos, CA 93620
dh@deneb.csustan.edu

This is the first issue for 1995, and it is exciting to be in the new year. Dayton is just around the corner as you read this, and I hope to meet and talk with you at the convention this year. NorCal will have a 10 member contingent traveling together and staying at the Days Inn Dayton South with the ARCI crew. Jim Cates and I will be in attendance at the hospitality room sponsored by ARCI on Friday and Saturday nights. Also, NorCal is giving away a full Sierra Kit with 5 band modules as the Grand Prize for the ARCI QRP banquet on Saturday night. Tickets will be available on Friday night, so be sure to attend and have a chance at winning a Sierra.

There are lots of great articles in this issue, and I appreciate all of the help that I have had in obtaining them. You will also note that there are a couple of corrections to the December issue. If you are building the Epiphyte, be sure to check them out.

NorCal has another project in the works. It is the Cascade, a dual band SSB rig that is being designed by John Liebenrood, K7RO. The design goals are for a simple entry level SSB kit that will be easy to build, simple, and fun to use. The Cascade will use a 5.0MHz VFO, homebrew 9.0MHz filter, and will tune 200 KHz on 75 and 20M. It will be housed in a Sierra case, and use the plug in band switching scheme that Wayne Burdick, N6KR, popularized in the Sierra. John has "ugly" constructed the prototype, and has it in a Sierra case. It puts out about 9 watts PEP on 75, and 5 Watts PEP on 20. We hope to have 4 of the prototypes built from a pcboard by Dayton. NorCal plans to kit the rig, and it has a target price of less than $150, complete. We should be able to tell you more at Dayton. 72, Doug, KI6DS

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Jim Cates, WA6GER
3241Eastwood Rd.
Sacramento, CA 95821

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THE DB-25 CHALLENGE, PHASE II

By Michael A. Czuhajewski WA8MCQ
7945 Citadel Drive
Severn, MD 21144
wa8mcq@hambbs.wb3ffv.ampr.org

The October 1994 issue of QST had an article on building a QRP rig (the Oner) into the cardboard box that 35mm film comes in. I enjoyed it and am always interested in little rigs, but some of us in Maryland went way beyond that several years ago. We built our rigs into little plastic bottles that rattle around inside the plastic 35mm film canisters, and have only 3/4 cubic inch of volume (about a third of the space in the film can and a sixth of the volume of the box), and more complicated than the Oner, to boot.

Is this practical? Of course not, but it wasn't meant to be. What it is supposed to be is fun, and it certainly was. The April 1990 issue of the QRP Quarterly had a couple articles on what we called the DB-25 Challenge. The origin of the name: DB-25 connectors with crimp-on pins often come with the pins in a little plastic bottle, and we chose the most common (and smallest) size. The idea was to put in a transmitter, receiver or transceiver, but we had a long list of specifications and restrictions. Did I think it was possible? A transmitter, probably, but a transceiver? No way, although the originator of the challenge, Robbie, WG3R, thought otherwise. As it turned out, he was right.

For receivers, no crystal radios, one transistor regenerative jobs or other "gimmicks"; it had to be something more substantial. For a transmitter, there had to be a minimum of an oscillator, amplifier, and final amplifier stage, and it had to put out enough power to make multiple contacts on the air. (We realized that wasn't really much of a limitation to seasoned QRPers—I have lots of fun in the double and single digit milliwatts—but it was agreed that we should have at least 100-250 milliwatts output.) It also had to fully meet FCC requirements for harmonic content; in lieu of doing spectrum analyzer tests, use of a pi net low pass filter was considered acceptable. Again, no single transistor units allowed. The frequency was not specified, and could be MF through VHF.

Mechanical considerations—connectors could be used, and "extra credit" was awarded if they were, but it was perfectly legal to bring out everything on wires and cables and use external connectors on the end. (Some 2 meter rigs have done that over the years, with power, antenna and microphone lines.) If crystal controlled, the crystal could be external to the bottle, but if it was VFO controlled, that had to be inside. For this initial challenge, surface mount parts were forbidden.

I crammed lots of very small parts together and wasted most of the volume with my 3 stage 40M transmitter. Paul Pinkowski, N2GAR, thumbed his nose at the small area and deliberately used bigger parts, like T50-2 toroids, silver mica caps, etc, to almost completely fill the volume with his transmitter. Now comes the fun part—Hal Bower, WA5JAY, put a complete 40M CW transceiver, with VFO, into his bottle! Tuning was done with a jewelers screwdriver stuck through a hole in the side. For the final amp he used a Radio Shack power FET with the heat sink tab cut off, running a few hundred milliwatts.

He let me use it to check into the Saturday morning QRP net on 7040 KHz, and the April 1990 issue of the QRP Quarterly has it on the cover. It was not an April Fool joke, and I took it to Dayton to prove it to the QRP crowd! (For an encore presentation, he built a 20 meter single sideband (not DSB) superhet rig into a 3 X 3 X 3/4 box, which was featured in the Idea Exchange in the Quarterly.)

Finally, Robbie made a CW transceiver (with VFO) with a pair of TFM-2 mixers from MiniCircuits, for a phasing direct conversion receiver with single signal reception! While Paul and I used a single rectangular piece of perf board, both Robbie and Hal made

QRP high rises with several layers, each built on discs of brass or perf board.

We agreed from Day One that the bottle would only be the start of the challenge. For a few years Robbie talked about putting something into one of those little tin boxes that a dozen aspirin tablets come in, but nothing ever came of it. (I always admire people who build rigs into Sucrets boxes, but we were already waaaaay beyond that stage!) Finally, in the summer of 1994 he came up with something that "clicked" with us—the long-awaited Phase II of the DB-25 Challenge would be in a fuse box! If you buy a box of 5 cartridge fuses (such as the AGC type), they come in a little box which is about 1 1/2 X 1 1/4 and a little over 1/4" high. The older ones consist of a plastic tray and sliding metal cover, although some newer ones have a hinged plastic lid. The one with the metal cover is preferred.

Three of the original DB-25 Gang of Four have signed up, and WA5JAY is considering it. The rules are similar, except this time surface mount devices are permitted. Although the volume on this one is down to 0.49 cubic inch, it's rectangular, which makes things easier than the cylindrical bottle.

At this point, in October 1994, no one has done much actual wiring but we're having some very serious discussions about circuitry, construction methods, etc. I'll do a VFO transmitter this time around; I'm not quite up to doing a transceiver yet, although Robbie has no choice since he's the one who threw down the gauntlet! I used DB-25 pins tied to the perf board for connectors the last time, with output brought out on a piece of RG-174 coax to a BNC plug. This time I will be using an SMA connector for output and some sort of computer header connectors. I haven't settled on capacitor or varactor/potentiometer tuning yet, but getting parts of either sort small enough to fit into the box isn't a problem these days.

Paul has a small start already; he's not sure if it will be CW or FM in the end, but he has the oscillator working for a 2 meter rig. He took a VHF crystal oscillator module (metal, DIP package), removed the substrate from the package and replaced the crystal with one for 148.000 MHZ and pulls it down into the band. He asked if it was "legal" to use a ready made oscillator like that and we allowed it; our view is that it's no different from using an IC.

Robbie also presented an alternative form for Phase II, although I think this one might become Phase III instead: build something into a 9 volt transistor radio battery case. That sounds easy enough—lots of space—but the catch is that the battery must still be operational and power the device! We'll be allowed to remove one or more cells and build into the vacated space. Naturally, the fewer removed the better—more available voltage, although less space. (Hint—there are two different types of transistor batteries; one has cylindrical cells, the other has little flat brick-like cells. It's a lot easier to build into a rectangle than a long, narrow cylinder.)

If anyone would like to join the DB-25 crew, at any level, we'd love to have you! And if you want to break yourself in gradually by starting with something "huge" in a Sucrets box, go for it! Even something that "big" can be a lot of fun, and is certainly an accomplishment to be proud of. (And don't forget to report your success to one of the QRP journals!)

Comparison of volumes:

35mm box 4.83 cu in
35mm film can 2.09 cu in
DB-25 bottle 0.78 cu in
Fuse box 0.49 cu in

HW-8 Mod: More Power vs. More Harmonics

By Michael A. Czuhajewski WA8MCQ
7945 Citadel Drive
Severn, MD 21144

An article appeared recently in both the New England and Northern California QRP journals about getting more power output on 15M from the HW-8 by pulling some turns off the output network coils, and it suggested that the Heath engineers (or someone else in the kit production process) blew it somehow.

He was partially right, in that Heath did not design the network for maximum power output, and that you can modify it to get more. However, maximum power output is not the only consideration when designing a filter, and this modification substantially degrades the harmonic rejection. I contend that Heath did design the 15M network correctly, when both power and spectral purity are taken into consideration, and two other ham friends who are engineers also came to the same conclusion after their own studies.

I did simulations of the network using Touchstone, professional grade RF/microwave software from EESOF (costing in the vicinity of ten thousand dollars, which I use at work, not at home!). It shows the optimum values for max output are somewhere between the Heath values (both 1.3 uH) and his (both 0.6 uH), around 0.7 and 0.9 uH respectively for the two coils. I came up with slightly different values each time I ran the optimizer since I was using the random function and there were 4 variables involved. However, the coil values were always in the same neighborhood.

After checking the quality of match between the final amp and output network with a variety of inductor values, I did plots of frequency response and found it quite interesting. The stock Heath circuit may give less power but it provides about 30 dB attenuation to the 2nd harmonic, while the higher power modification gives only 15 dB! The Touchstone optimization for maximum power was in between, at 20 dB. (I tried a value of 1.5 uH for both inductors, and it gave 32 dB but even less power.) Initial runs were done with ideal components, ie, infinite Q. I later repeated them with real-world values of Q for the coils, and results were similar.

FCC rules do not require that we use filters with a certain amount of attenuation; they only specify that spurious output from our stations (including harmonics) be at least 30 dB below the carrier at 5 watts and under (and 40 dB for higher powers), as well as a maximum of 50 mW in any case. How we do that is up to us; if you can still achieve at least 30 dB of harmonic attenuation at the output of the HW-8, which may require additional filtering beyond the modified network, then FCC requirements will be satisfied although insertion loss could eat up some of the power increase.

Do we really need to keep the existing network? Remember that the HW-8 was designed back in the days when transistor transmitter design was done differently than it is now. Although the HW-8 output provides for a certain amount of latitude in antenna impedance, as did vacuum tube rigs of the day, virtually everything now is designed for a fixed 50 ohm load, followed by an external antenna tuner. A 5 or 7 element Chebyshev low pass filter from the tables in the ARRL handbook might be a better replacement for the existing 15M output network, at least with respect to harmonic suppression.

I selected a 5 element Chebyshev low pass filter with 0.1 dB ripple (which gives a good tradeoff between input SWR and harmonic attenuation), scaled for a cutoff of 22 MHz. Touchstone tells me it has 32 dB at the 2nd harmonic. Unfortunately, it requires nonstandard capacitor values. I picked a 7 element Chebyshev using standard capacitor values, and it gives 48 dB (and takes a lot of parts). Both have quite low insertion loss at 21 MHz. By contrast, a simple 5 element half wave pi low pass filter (such as p. 170 of

the W1FB QRP Notebook, 2nd edition) gives only 20 dB. Depending on the amount of harmonic energy present at the final amp, even 20 dB attenuation could be sufficient to meet FCC specs. I haven't done any spectrum analyzer tests on an HW-8 yet.

Incidentally, Touchstone shows that the existing HW-8 networks for the other bands give a better match between the final amp and load than does the 15M network, i. e., more power, and also provide good harmonic suppression to boot. In the article, the author said he calculated the resonant frequency for the HW-8 network and found it was around 13 MHz. I scratched my head over how he did it, did calculations with a variety of component combinations and managed to come up with a ball park value of about 11 MHz. But when I used the same approach to the other bands, they all showed a "resonant frequency" of very roughly half the operating frequency as well, and those bands work quite well, thank you.

The bottom line is that you should not modify the output network for 15M on the HW-8 unless you really know what you are doing with respect to filter design and frequency response and are aware of all the consequences, and perhaps provide for some additional harmonic attenuation past the output of the modified network to stay FCC-legal.

My HW-8 has been dead in the water for a couple years since I cannibalized both of the cans used in the heterodyne oscillator to get someone elses running. I eventually replaced them with Toko coils (another article to write!), and some day I'll get around to doing some tests with the standard and modified 15M coils, using a spectrum analyzer. I'll pass along the results when I do.
—WA8MCQ

A Cool 5 Watts for your NorCal 40

by Dave Meacham, W6EMD
206 Frances Lane
Redwood City, CA 94062

I wanted to be able to run my NorCal 40 at 5 watts output, key down, for extended periods without overheating problems. I decided on the TO-220 PA package for ease of connecting a heat sink. Further, I wanted the mounting tab to be the emitter so I could ground it. The MRF-260 has these features but only 10 dB of rated gain. It is also pricey at $14.50 (R.F. Parts Co.). Well, I bit the bullet and I am glad that I did it! With a 13.8 Volt supply the rig will now deliver 5 watts for time periods measured in minutes, not seconds, with no overheating. As an example, a 5 MINUTE run yielded a barely warm PA and the same for the driver.

Key elements in this mod are a small, inverted top hat type of push on heat radiator for the driver and a copper heat conductor for the PA. The driver, incidentally, is a 2N5109 CATV transistor ($1.50) from OHR. Its pinout is wrong for the NorCal 40 board holes so you have to bend the base lead back and then down to the board (same as if you used an MRF-237 PA). The 2N5109 base view pinout going clockwise from the tab is emitter, base, collector. The huskier 2N5109 driver is necessary because of the low gain of the PA transistor.

Heat from the PA is conducted to the back panel by a piece of 0.040 inch thick copper sheet 5/8 inch wide by 2 inches long. Three quarters of an inch of the conductor is flat against the back panel, vertically, held by two 4-40 screws and nuts. At the bottom of the vertical section the copper is bent 90 degrees so it is horizontal, heading toward the front panel. At 1/2 inch away from the first bend another bend is made downward at about 45 degrees. At this point the width is tapered down to 3/8 of an inch to match the width of the

TO-220 case. A 6-32 clearance hole is centered 0.40 inches from the end. A 6-32 screw (and nut) holds the heat conductor to the MRF-260 which is tilted toward the back panel with its mounting surface up and positioned UNDER the copper strip. Its pinout is base, emitter, collector, left to right, front view, pins down. Mount it with the front facing the back panel. The base and emitter leads fit well into the original board holes, but the collector lead has to be bent toward the back panel at the board surface, and angled toward U5 to fit into the original board hole.

A binocular-core output transformer is used per the KN6VO article in the June 94 QRPp, (Pp 44-45). I changed the turns to 3:5 and used the same circuit as on p. 45. I mounted the core on edge with a wire strap, with the holes horizontal, between C46 and Q7.

Other changes are as follows:

C45 = 370 pF (low 390) S.M.
C46 = 780 pF (510 + 270) S.M. paralleled
C47 = 390 pF S.M.
L7, 8 = 19T #26 on a T37-6 core (yellow), 1.08 uH
Q6 = 2N5109
Q7 = MRF-260
R11 = 820 ohms
R12 = 3.3 ohms
R13 = shorted
R14 = 47 ohms
RFC1 (KN6VO schematic) 4.7 uH, 620 mA, (Mouser 43LS476).

Current draw on transmit is 575 mA for an overall efficiency of 63%. Finally, my spectrum analyzer shows that all spurs and harmonics are 45 dB down or more.

72, Dave, W6EMD

Member Profile: Jim Pepper, W6QIF

by Jim Pepper, W6QIF
44 El Camino Moraga
Orinda, CA 94563

I became interested in radio at the age of ten as a result of my father's interest in radio building. He never became a ham but was of the generation that got started in radio after WWI in the 20's and 30's.

My interest was tweaked after reading an article in one of my father's radio magazines called "Pilot Radio", a Guernsback publication. The article was on a ham transmitter using a TPTG (tuned plate-tuned grid) '45 tube. Of course by this time I had already built several crystal sets using gallium crystals and cat whiskers to rectify the rf signal. My first radio was a three tube regenerative receiver that covered the bc and the 160 meter band. In those days (mid 30's) the 160 meter band was the dream band. No matter what time of day or night there was always someone on to talk to.

I didn't get my license until I was 16. To pass the exam required 13 wpm receiving and transmitting. The written exam was of the essay type. A favorite question was to draw a schematic of the transmitter you were going to use and briefly explain its operation. How many can do that today? Fortunately, I passed the first time and was on the air in 1938 on 80 CW. My first contact was rather scary, as it is with many people, especially on CW.

From 1943-45, I was in the combat engineers as a radio operator and repairman. Being a service man, I took advantage of the GI bill and graduated from UC Berkeley in

EE. I have worked for a number of electronic companies including Beckman Instruments and the Rad Lab at Berkeley. In my retirement years, I have taught the license preparation classes for the Mount Diablo Radio Club. I have had four articles published, two in 73, one in Ham Radio and one in Communication Quarterly.

My main ham interest today is still in building and testing ham equipment and I hope some of my contributions to QRPp will inspire you to build not only kits but designs of your own. That is the way you really learn about radio.

72, Jim Pepper

NorCal Sierra Construction

by Bruce Florip, AA7AR
441 Greenwood Dr.
Santa Clara, CA 95054

After a quick walk around the Ham-Swap at Los Positas College in Livermore, Ca. I drove over to meet the NorCal Group at California Burger. Doug (KI6DS) and Jim (WA6GER) were both there as always. Doug was handing out the December issue of the NorCal Journal. The club get togthers are always an inspiration!

The first thing that caught my eye was a very professional looking Sierra on one of the tables. The proud builder Stan (K4DRD) invited me to join him at the table and take a look at the rig. Stan's rig looked better than anything I've seen offered on the commercial market, complete with a gray front panel silk-screened in white lettering. He's added a keyer and S meter which really looked as though some thought and effort went into the work.

As a side note, as mentioned in the Sierra Manual, Stan is offering to silk-screen the front and rear panels of those that send the (painted) panels to him. Again, great club spirit, and I hope those who do remember to include postage, as Stan has already invested probably at least $100 US dollars in the silk-screens (3 different artworks), and the required ink or paints... Remember if you do send boards to Stan, let the paint cure (harden) for a few days before you mail them to him. He reported panels arriving with textured paint matching the packing material used for shipping!

All of this began as a start to building my Sierra which arrived about a week ago. The trip to the club meeting really "sparked me up". Now I really want to build mine!

I'll start by reading the December QRPp to see what Wayne (N6KR) has to say in his article "Sierra Problems: Q & A"

Most of the items mentioned there seem to be performance related (to be handled after the rig is completed), but there were two items to keep in mind during construction:

1) The boards are double sided, so be careful when installing components that could short other traces together (Crystals, transistors, etc.). Space them up off the board slightly.

2) Resist the urge to socket the parts due to possible instability.

Now, let's see... here's another article by Wayne about the Sierra! "The NorCal Sierra" Very interesting and VERY informative. The insights into the design of the Sierra transceiver as well as general transceiver design are a rare treat. It's extremely rare that the designer of anything is the author of the technical documentation! That fact alone reveals the well rounded talents of Wayne. Now, where is that "PRIORITY MAIL" package with the Sierra in it?

I know it sounds too good to be true, but the package arrived at my house in great shape, so no worries of lost parts! On top of that, Jim Cates did a great job of packaging including an inner bubble-pack envelope taped shut. Great Job! Wait, all the parts were in zip-lock baggies, and the circuit boards are taped carefully inside of the aluminum cabinet halves. It's attention to detail like this that make the NorCal club what it is. Thank You to

Jim and his helpers for a great job kitting the Sierra.

Once I got the PC board out of the packaging, I was very impressed! I know people usually refer to the layout of a board as an artwork, but this one really is. Double-sided with white silk-screening, and plated-through holes. This board reminds me of HP or Tektronics quality... amazing for a "club kit".

One thing the pre-tinned solder pads reminds me that I promised myself after some less than perfect soldering due to "Swap-meet" solder. It's usually surplus for a reason.... No soldering until I visit the Fry's Electronics store for some good quality solder!!!

Soldering:

This seems like a good time to investigate why one roll of solder produced a better looking joint than another. The various rolls of solder in the ham shack were collected and are described below:

Roll #	Brand	Tin/Lead Mix	Size/Melting Point	Use?
1	Solder Rosin Core	40/60	.032" 450 f	trash
2	Kester Resin "44"	60/40	.031 370 f	keep
3	Kester Resin "44" core 66	63/37	.025 361 f	use!
4	Triple Core by Tech Spray	60/40	.031 370 f	keep
5	Unmarked	? ? ?		keep

Roll number one was the culprit in the last poor looking solder job. You should notice what I didn't at the swap meet. This isn't the usual 60/40 although the numbers are right, the order isn't The percentage of Tin comes first, then the amount of lead. I wish I had noticed that BEFORE I bought it. A dollar for a pound of unusable solder isn't a bargain...

The Radio Amateurs Handbook has a section on soldering. Since you probably won't drop what you're doing and run for the Handbook, I'll tell you what I found. Tin melts at 450 degrees f, and Lead at 621 degrees f, you can see where the trouble with roll number one started.

The handbook has an informative graph which shows the melting points for all the possible Tin/Lead mixes from 90/10 to 10/90. Something interesting about solder mixes as well, 63/37 is the only ratio that doesn't go through what the handbook calls plastic state. I'd call that paste state... Let me quote a few portions of the handbook exactly as it seems very important to the final product. See, I do still remember that the title back there was the NorCal Sierra!

"...solder that is not 63-37 goes through a plastic state. If the solder is deformed while it is in the plastic state, that deformation will remain when the solder freezes into the solid state. Any stress or motion applied to "plastic solder" will result in a poor solder joint"

My first response to that was going to be rush over and trash all but the 63/37 solder and start the Sierra. Just think, no pasty looking joints. Then I read on a little more in the handbook.

"A 60-40 solder has the best wetting qualities. Wetting is the ability to spread rapidly and alloy uniformly. Soldering is not like gluing. The solder does more than bind pieces of metal together and provide an electrically conductive path between them. In the soldering process, the materials being joined and the solder combine to form an alloy..." Now the bets are favoring the 60/40 mix.

The handbook goes on to say: "Because of it's low melting point, small plastic area and excellent wetting characteristics, 60-40 solder is the most commonly used alloy in electronics." So, keep the 60/40 for the Sierra, put the 63/37 in the drawer, and move the 40/60 to the garage for "radiator repair"...

The last thing to be sure of is that you have a good quality rosin core solder, and NOT ACID CORE. that's also to me moved to the garage for radiator repair! Also remember, the rosin or flux doesn't clean the joint, it removes oxide by floating it to the top. So, start

by cleaning the joint, then solder. I find the pink soft erasers made for pencil lead work wonders for cleaning PC boards prior to soldering. Oh, and after you clean it, don't touch it. There are lots of nasty oils and such on your fingers that can ruin a good solder joint. Now wait, I was already to start, and it's 10:45 P.M. The good thing is my Sierra will be better for a little time spent up front.

Since it's too late to start, I'll read the Sierra manual and get a fresh start later. You're probably getting tired of the compliments by now, but the front cover of the manual is as the kids might say "Very Cool". A map of the Sierras and the band plan overlaid with an artistic view of a completed Sierra. Would it be too much to ask for a color print version to frame and hang in the shack?

A week has passed, there has been some building and flying model airplanes, a week's worth of work, and it's time to work on the Sierra!

With the soldering issues out of the way, and the "PanaVise" with the PC board holder on the bench things seem to be ready.

Now to find the manual... Let's see that was bedtime reading material... Got it, only three or four deep in the pile; QRPp, QST, and Model Aviation ahead of it. The cover looks great, I didn't notice the heavy woven look to the cover before. This really was a club project right?

The kit is unpacked, and on the bench in front of me:

* 2 each case halves
* Front and rear panels
* PC Board (in a plastic bag)
* 2 each silk screened Plexiglas tuning scales
* hardware bag (rubber feet, tuning capacitor, knobs, case latches, power plug etc.)
* Sierra main kit bag (lots of parts!)
* 3 each bags of band modules, 40, 30 and 15 as ordered.

The urge to start building is nearly overwhelming, but the manual says to inventory all of the parts in the kit. The author has been right on the money so far...

Just had an idea. Since the parts have to be inventoried anyway, and since after the automatic ice maker went in the old trays are "surplus", why not sort into the capacitor tray, the resistor tray, the inductor tray, and the misc. hardware tray. Since you're "watching" all this happen, you can be the judge if it was worth the effort.

There's a box of old business cards just waiting to be cut up to label the "cube holes". Cut in thirds across the wide direction, they look just about right. Since the electrolytic types are easy to distinguish from the disks, they can share a "cube hole".

First question is how do you tell the difference between a disk cap marked 270 and 270J either could be a 27 (0 multiplier) or a 270 pf. Those will be measured later. As the sorting continued, a disk capacitor marked 27 showed up. The 270J caps go in one pile, the ones marked 270 in another, and those marked 27 will be assumed 27 pf for now.

When checking the knobs for the 2 Allen screws, the missing 4-40 X 3/16 screw was found.

The parts list shows a quantity of 1 for the dial set screws, where 2 should be. The LM 358 is missing, and there are two of the LM 393s. There is a mysterious 220K resistor with no home as yet.

Almost forgot! Included in the kit was a list of 9 corrections to the manual, some good charts on wire length for number of turns on a toroid, a color code sheet, and some additional notes on the Sierra. These were the items found by the guys who built the early production run kits. So if you were feeling blue about being on the end of the list of guys to receive your Sierra don't. There are some benefits for not being first!

The corrections should have priority in your reading. Read them PRIOR to reading the manual. They are corrections and additions to the manual you'll be using to assemble the rig.

By now the resistors except for the front panel potentiometers are on. Since the PC board is in a vice, the pots would get in the way. The diodes are installed and double checked, and a few of the disk capacitors are installed. So far, the ice cube trays for temporary parts storage during construction are highly recommended. It's great to reach down and pick up each of the parts when they're needed instead of digging in the plastic bag. It seemed a bit of a waste of time in the beginning, but not now.

Things are going well, but no speed records are being broken. Hopefully the time spent now will save debug time later. It may interest some to know that all of the resistors were checked prior to installation for proper value. That may not have been worth the time, since they were all within tolerance. It's late, time to stop before the mistakes begin.

OK, now just so you don't think things are any different in the AA7AR/6 ham shack Days have passed... This is nothing like the reports heard at the last NorCal Meeting... I think some of those guys said something around 8 hours! My best excuse is trying to avoid mistakes, and measuring every part just to be sure.

Time to step back and see where things are:

* Resistors are in, all but the ones with r numbers 100 or greater.
* Diodes are in.
* RF chokes are in (the ones you don't have to wind)
* Capacitors are in except for the one used for main tuning (vice clearance)

Looks as though it's time for ICs and transistors... I tried to pick up an LM 358 but the surplus store I tried had an empty drawer labeled LM 358. One more try tomorrow.

OK! As we all know, family comes first. Consequently the Thanksgiving holiday has come and gone, and it's back to the Sierra! By this time, those guys that completed their Sierras in hours instead of days are probably wondering why it's taking so long...

J2 and S1 were installed as they don't interfere with the vise. J5 went in smoothly, all 50 solder connections, and the mounting screws with standoffs.

The LM-358 turned out to be a lesson in semiconductor part-numbering. The local electronics store didn't even have a position for the LM-358. While I was browsing for interesting chips I noticed an op-amp that sounded similar to what I needed, and the partnumber was close... LM-258. At a dollar seventy-nine for 2, it was cheaper to buy and investigate at home than to come back, so off I went.

The National Semiconductor Linear Databook was the solution to the mystery. As it turns out, the part number tells us a great deal of information about the part:

Device Family	**Device Number**	**Package**
LM	258A	N
AD - Analog to Digital	1xx/2xx/3xx	* D - Glass/Metal DIP
AH - Analog Hybrid	3,4,or 5 Digit Suff. Indicator	F - Glass/metal Flat Pack
AM - Analog Monolithic	* A - Improved Elec. Spec.	H - TO-5, 99, 100, or 46
CD - CMOS Digital	* C - Commercial Temp Spec.	J - Low Temp Glass DIP
DA - Digital to Analog		K- TO-3 (Steel)
DM - Digital Monolithic		KC- TO-3 (Aluminum)
LF - Linear FET		N - Plastic DIP
LH - Linear Hybrid		P - TO-202 (D-40, Durawatt)
LM - Linear Monolithic		S - "SGS" type Power DIP
LX - Transducer		T - TO-220
MM - MOS Monolithic		W -Low Temp Glass Flat-Pack
TBA - Linear Monolithi		Z - TO-92

* With most of National's proprietary linear circuits, a 1-2-3 numbering system is employed. The 1 denotes a Military temperature range device (-55_C to + 125_C), the 2 denotes an Industrial temperature range (-25_C to + 85_C), and the 3 denotes a Commercial temperature range device (0_C to + 70 _C), i.e. LM101/LM201/301. As it turns out, the LM-258 was a lucky buy. It's actually better than the LM-358, but only as far as temperature range.

After rotating the main PC board in the vise, the remaining jacks and switches were installed with no clearance problems... should have started with the front of the board facing out of the vice from the start.

The two coax jumpers were installed next. I chose to place them below the PC board. After looking at a couple of rigs with them on the component side, this seemed to be the best looking choice. By mounting them on the bottom, more care dressing the coax shield is required to prevent shorts. Heat shrink tubing was used. 3/32" on the shield wires, and 5/32" to cover the point where the outer insulation is removed from the shield. After installing the jumpers, there wasn't much room left when soldering R1 in place. Hindsight says it seems to be easiest to install the jumpers first if they are installed on the top of the board. If the jumpers are installed on the other side, install R1 first. That should avoid melting the covering on the coax jumpers.

As a precaution, when mounting the potentiometers, the headphone jack and RIT switch were mounted to the main board first. This allowed the front panel to be installed to hold the controls in the correct position for soldering. The nuts on the variable resistors were temporarily installed to be sure they were flush with the panel. The tuning capacitor and the headphone jack on my rig were the reference points for the panel installation.

Also note, I didn't remove the small tabs on the Potentiometers as listed in the instructions. Instead, they were bent in toward the shaft, nearly filling the areas they were punched from. This may be one of those "So, it makes no difference" points, but that's up to you.

The instructions were correct regarding the excess metal on the bottom of C54. I closed the plates completely to avoid bending them, Then held the body of the capacitor as I slid it across the top of a flat file. This flattened the bottom of the capacitor, and kept the filings in the garbage, and out of the capacitor plates and bearings. Great attention to detail in the assembly manual. Another thanks to Wayne is due. After the "file treatment" the bottom of the capacitor sat flat on the PC board, allowing both mounting screws to be installed with no worries of warping the PC board.

Instead of #22 or #24 wire for C54s connection to the main PCB, a 2 watt resistor lead was used. It fits snugly in the hole and should provide a good rigid connection to prevent mechanical instability.

Probably out of self-induced fear, the toroids were left until last... They all went in just as described. That completed the main board, and left only the completion of one of the band modules between here and the alignment and test.

The 40M band module went smoothly. There were a couple of things that got in my way slightly. OK, three...

My eyesight was one. My magnifying lamp and I spent a good deal of time together on this project.

The other two were very minor. My soldering iron got an upgrade to a smaller tip. Finally the one that had me looking at the schematic, the parts list, and the winding instructions was T1. The instructions list the primary as a 1 turn link, and the secondary as 16 turns #26, the same as L1. That was fine, and the winding was no problem. When I went back to the winding instructions, they said "Wind T1 in the same manor as described for T2 on the main PC board assembly. The only difference is that pins 3 and 4 are re-

versed...."

So, I went back to the winding instructions on page 10. There, the picture shows the primary as the winding with the large number of turns, and only a few on the secondary. After looking as the schematic, I found I should believe the parts list and the silk screen. The primary is the single turn link.

We'll skip over the dry detail of installing knobs and fasteners, that went fine.

There was only one word to describe the alignment: Wait, there are a ton of word that describe it! GREAT, EASY, COOL, FANTASTIC, IT WORKS!

I used a frequency counter and a scope, but found that although it made it super easy, everything was so close to being right on with the adjustments all set to their mid-points, that very little improvement was made during the alignment!

I still have yet to send my panels off to Stan Cooper as listed in the manual, and believe me I will. Stan brought his finished Sierra to the last NorCal Meeting in Livermore, Ca. That rig does not look like any kit I've ever seen. It looks great!

I love the filtering, and the smooth tuning. I've only worked two stations so far, but the QRP ARCI Sprint is tomorrow, so I know it will be thoroughly tested before it has paint and rubber feet!

I hope this gives those of you that for one reason or another won't get a chance to build a Sierra to get the feel of how much fun it was! I may have said this before, but if yours is still in the box.... You really should get going on it. Not only was it fun, the Sierra is a fantastic rig! 72, Bruce

Multi-Frequency Antenna Technique Uses Closely Coupled Resonators

by Gary A. Breed, K9AY
Editor, RF Design
6300 S. Syracuse Way, Suite 650
Englewood, CO 80111

This article describes a recently developed method for the design and construction of dipole and monopole antenna elements that operate on two, threee, four or more frequencies. This method permits such multi-frequency antennas to be built without reactive networks or tuned stubs, which are commonly used to obtain multiple resonances at a single feedpoint. The method also has the advantage of control over the feedpoint resistance and reactance at each frequency.

It is well known that conductors in close proximity exhibit strong mutual coupling. A design technique called the Coupled-Resonator (C-R) principle has been developed [1] which uses this coupling to great advantage. The C-R principle defines the conditions for optimum coupling, creating a system with multiple resonant frequencies, driven at a single feedpoint. Such a multiple-resonant structure consists of a driven dipole or monopole at the lowest frequency of operation, with additional resonant conductors surrounding it, placed at the appropriate distances.

Figure 1 demonstrates the C-R principle in its simplest form, a two-frequency system. A half-wavelength driven dipole is resonant at some frequency, F1, and driven at the center. A typical return loss sweep for such a dipole is depicted in Figure 1(a). In Figure 1(b), an additional conductor, half-wavelength resonant at an arbitrarily-chosen higher frequency, F2, is placed nearby. Some degree of coupling will exist between this conduc-

tor and the driven dipole, and the return loss sweep of the dipole feedpoint shows a "bump" at the resonant frequency of the second conductor.

The main premise of the coupled-resonator principle is that there is an optimum spacing distance where the coupling results in a matched condition at F2, as in Figure I(c). The return loss remains good at F1 and, therefore, the system is matched at both frequencies.

The above description also applies to systems where the driven element is a monopole fed against ground, given the equivalence of monopole and dipole configurations. In this case, the feedpoint impedance of a monopole will be one-half that of an equivalent dipole.

This two-frequency system can be expanded to three, four, five or more frequencies by adding additional resonators and placing them radially around the fed dipole or monopole, as shown in Figures 2 and 3. A practical upper limit on the number of frequencies this structure will support is reached when the complexity of multiple interactions obscures the desired coupling. The actual number of frequencies obtainable depends on various factors which determine the degree of coupling, such as harmonic resonances and small frequency separations. Systems up to seven frequencies have been successfully modeled.

Design Equations

The variables involved in the design of antennas using the C-R principle are: conductor diameter, conductor spacing, feedpoint impedance, and the ratio of frequencies. These are all defined from the point of reference of the additional frequency underconsideration, Fn.

Conductor spacing follows this general relationship:

$$\frac{\text{Log (d)}}{\text{Log (D/4)}} = .54$$

where d is the distance between conductors and D is the diameter of the conductors, both expressed in wavelengths at Fn. This approximation is normalized for a feedpoint impedance at Fn equal to that of the dipole in free space (72 ohms) or a monopole over perfect ground (36 ohms), and for an Fn/F1 ratio of 1.3 or greater.

For broader applicability, the equation can be modified to allow for a wider range of impedances and lower Fn/F1 ratios. Using a straight-line approximation for impedance and a first-order $1/e^{-x}$ curve-fit for frequency ratio correction, the original equation then becomes:

$$d_{1n} = 10^{[0.54 \text{ Log}(D/4)]} \text{ x } (Z_0 + 35.5)/109 \text{ x } [1 + e^{-[(((F_n/F_1)-1.1)x11.3)+0.1]}]$$

where Z_0 is the desired feedpoint impedance at F_n, within the range of 25 to 125 ohms. F_1 is the resonant frequency of the driven dipole. F_n is the resonant frequency of the addional resonator F_n/F_1 frequency ratio is greater than 1.1:1 d is in the range of 0.01 to 0.00001 wavelength.

A significant point is that the impedance can be independently controlled at each frequency, F_2, F_3 ... F_n, by adjustment of the spacing. Combined with the reactance change in an antenna as length is altered, a wide range of adjustment can be obtained.

There are two additional characteristics that can be explained by the simplified equivalent circuit shown in Figure 4. At F_n, the feedpoint impedance is the combination of Z_1,

the impedance of the driven dipole or monopole, and Z_n, the coupled-resonator impedance, plus Z_x, which is the total effect of any other resonators in the system (predominantly capacitance). Compensation for Z_x is readily achieved by simply lengthening the resonators to add inductance, typically by 0.25 to 0.5 percent

Another effect is an apparent anomaly that occurs when the ratio of F_n/F_1 is approximately 3, where a significant increase in the spacing is required. This is readily explained by noting that the driven dipole has a relatively low impedance at 3/2 wavelength (3/4 wavelength for a monopole). In this case, Z_n must be higher than normal to achieve the desired parallel combination of Z_1 and Z_n, which corresponds to a greater spacing distance.

Radiation Characteristics

Antennas designed according to the C-R principle are accurately modeled using method-of-moments analysis, including software based on either the Numerical Electromagnetics Code (NEC) or MININEC3 [2]. Figure 5 shows the modeled free-space radiation pattern of a three-frequency C-R dipole, using the program ELNEC [3]. The modeled directivity (gain) is shown at the highest of the three frequencies, and is very close to that of a simple dipole (.0.5 dB greater), suggesting that radiation is primarily from the resonant conductor. The slight gain over a dipole at this highest frequency also suggests that small in-phase current is present in the portion of the driven dipole which extends beyond the active region. Analysis of the currents in the antenna model verifies these conclusions.

Advantages and Limitations

The principal advantage of this antenna design is the absence of reactive components, such as tuned circuits or capacitively-loaded coaxial stubs, which are often used to achieve multi-frequency operation. These components may introduce losses, or require time-consuming tuning adjustment. The C-R antenna design achieves its performance by controlling the physical dimensions of conductor length, diameter and spacing.

Another significant advantage is that the feedpoint impedance at each additional frequency can be controlled by adjustment of resonator spacing and length. When a C-R antenna element is placed in an array, the mutual impedances can be significantly different at each operating frequency. The C-R principle allows each frequency's resonator to be adjusted over a useful range of resistive and reactive impedance.

Two limitations should be noted. First, the tradeoff for electrical simplicity is a relatively complex mechanical assembly. The structure must support a central dipole or monopole and maintain spacing with the additional resonators with insulators or other means. However, it should be noted that other multi-frequency configurations also have special construction requirements. The other limitation of the C-R method is a reduction in VSWR bandwidth at F2; F3 and any higher frequencies of operation, compared to a simple dipole or monopole. This shortcoming can be mitigated by the use of large-diameter conductors, or in extreme cases, additional resonators with overlapping coverage. Again, other common multi-frequency antenna designs also exhibit reduced bandwidth, although some have losses which reduce the system Q and create an apparent increase in bandwidth.

A Practical Antenna

Various antennas were verify the accuracy of the computer models, and to assure that the concept was valid. The first versions of these antennas were designed for H F amateur radio bands, where they could be evaluated "on the air" and compared with other antennas

of known performance. Since the early development of this antenna design was a purely personal endeavor, this arrangement allowed extensive experimentation in conjunction with enjoyment of the hobby.

Figure 6 shows the dimensions of a three-frequency dipole constructed from #12 AWG wire. The driven dipole is resonant at 10.1 MHz, with additional resonators for 18.1 and 24.9 MHz. Using equation (2), and choosing 50 ohms as the design impedance for F2 and F3, the required spacing was determined to be approximately 1.75 inches (4.5 cm) for each resonator. After modeling the design in ELNEC, the spacing was increased to 2.0 inches (5 cm), primarily to compensate for installation above real ground at a design height of 45 feet (13.7 m). Figure 7 is a detail photo of the feedpoint region. Figure 8 is a return loss sweep from 8 to 28 MHz. The ripple in the display is caused by small reflections in the long test cables. Return loss is greater than 20 dB at the three design frequencies, exceeding 30 dB at the highest two frequencies (those added by coupled-resonators). 30 dB corresponds to a VSWR of 1.06:1.

On-air performance of the three-band antenna proved to be indistinguishable from that of separate dipoles for each band. The radiated performance, the feedpoint impedance, and the variations in impedance with installation height above ground also served to confirm the validity of the MININEC-based ELNEC model.

Applications

Design investigations are proceeding into several specific applications where the ability to cover two or more frequencies in a single antenna would be useful. These applications include combined cellular/PCS bands, 915/2450/5700 MHz ISM bands, 150/450 MHz mobile radio, international shortwave broadcasting, amateur radio and others.

Summary

This article has introduced the reader to the Coupled-Resonator principle, a method for the design and construction of multiple-frequency antenna elements which uses controlled coupling of closely-spaced conductors. Although other methods exist for multi-frequency anten nas, this method offers a new option for antenna construction. Using this method, frequencies of operation can be arbitrarily chosen, the impedance at each frequency can be controlled to a significant degree, and operation is obtained without the use of reactive isolating circuits or stubs. This design method is patent-pending. RF

References

1. Gary A. Breed, "A Method for Constructing Multiple-Frequency Dipole or Monopole Antenna Elements Using Closely-Coupled Resonators," patentpending, July 1994.

2. J.C. Logan, J.W. Rockaway, "The New MININEC (Version 3): A Mini-Numerical Electromagnetics Code," Naval Ocean Systems Center Technical Document No. 938, September 1986.

3. ELNEC antenna analysis program, available from Roy Lewallen, P.O. Box 6658, Beaverton, OR 97007.

[Gary Breed is Editor and Associate Publisher of RF Design, and Editorial Director of EMC Test & Design. He maintains an active interest in the design areas of: antennas, low-cost transmitting and receiving equipment, power amplifiers and zero-IF techniques. Gary can be contacted at RF Design, 6300 S. Syracuse Way, Suite 650, Englewood, CO 80111, or by telephone at (303) 220-0600.]

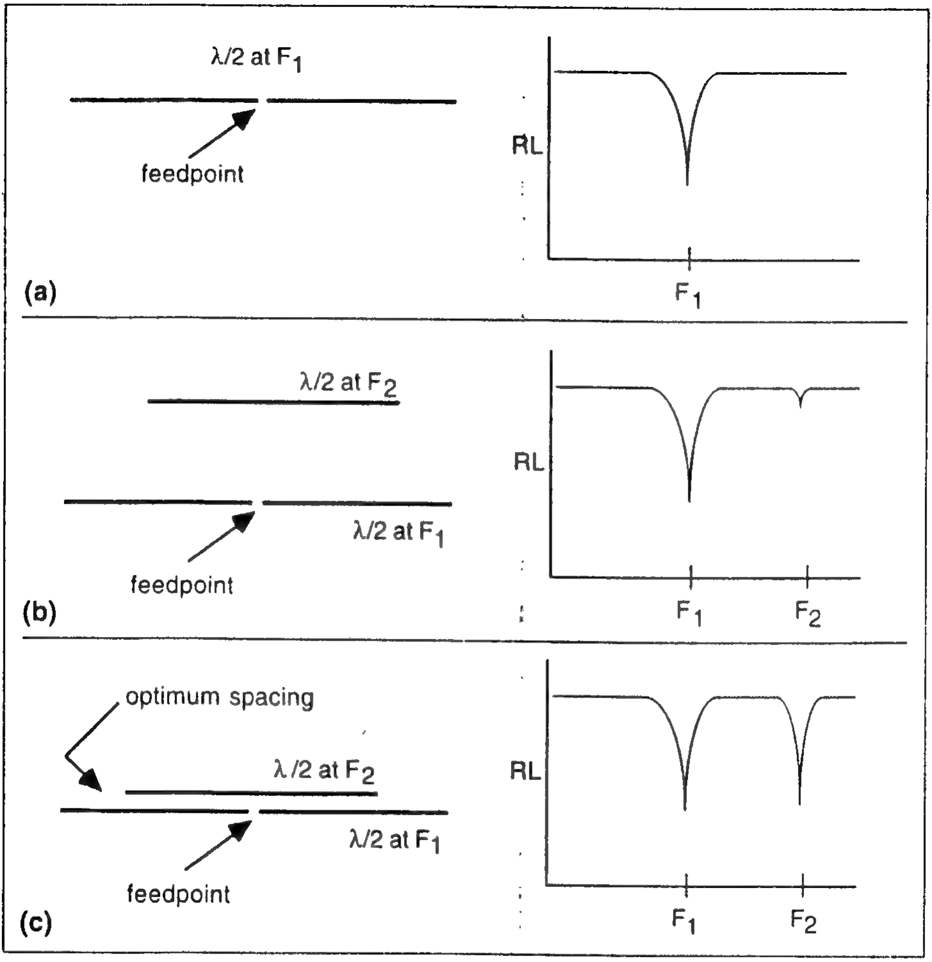


Figure 1. Coupled-resonator behavior: (a) shows a simple dipole and its typical return loss sweep; (b) illustrates the effect of an additional conductor placed in the vicinity of the first dipole, and; (c) shows how a two frequency system appears when the spacing of the second conductor is such that coupling is optimum.

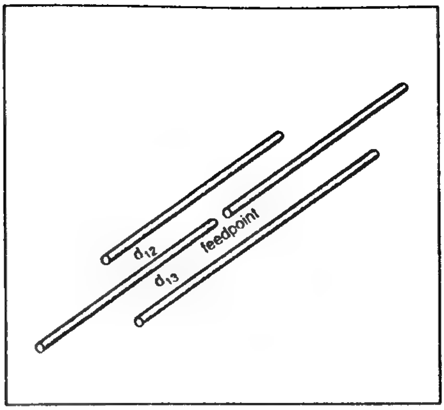


Fig. 2. Pictorial representation of a 3 frequency C-R Dipole

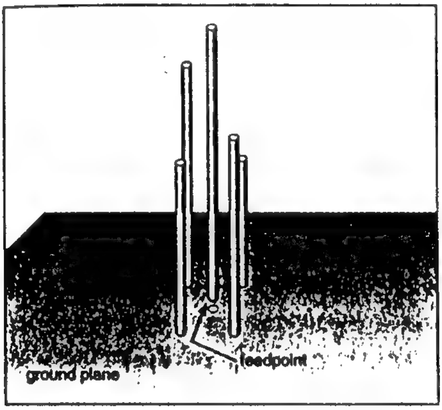


Fig. 3. Pictorial of a 5 frequency C-R monopole element.

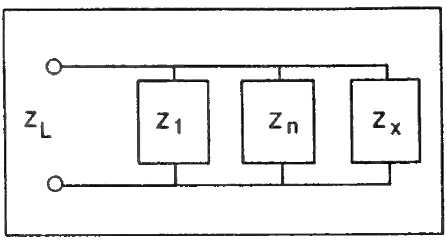


Fig. 4. Simplified equivalent circuit at F_n

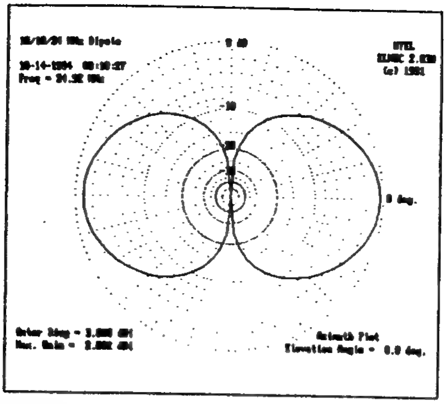


Fig. 5. Modeled radiation pattern at the highest frequency of a 3 frequency C-R dipole.

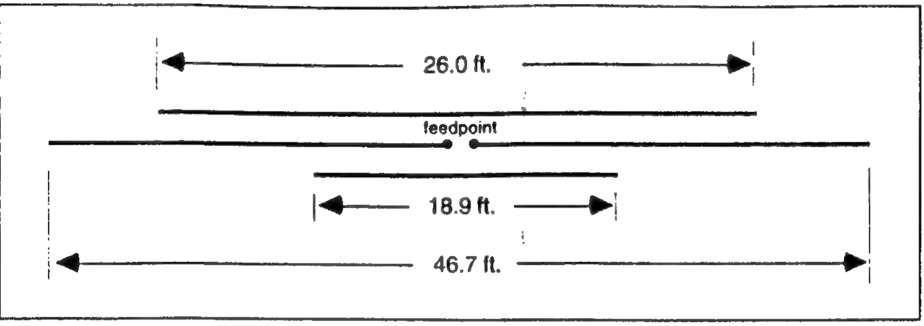


Fig. 6. As built dimensions of a 3 frequency C-R antenna for 10.1, 18.1, and 24.9 MHz, using #12AWG conductors.

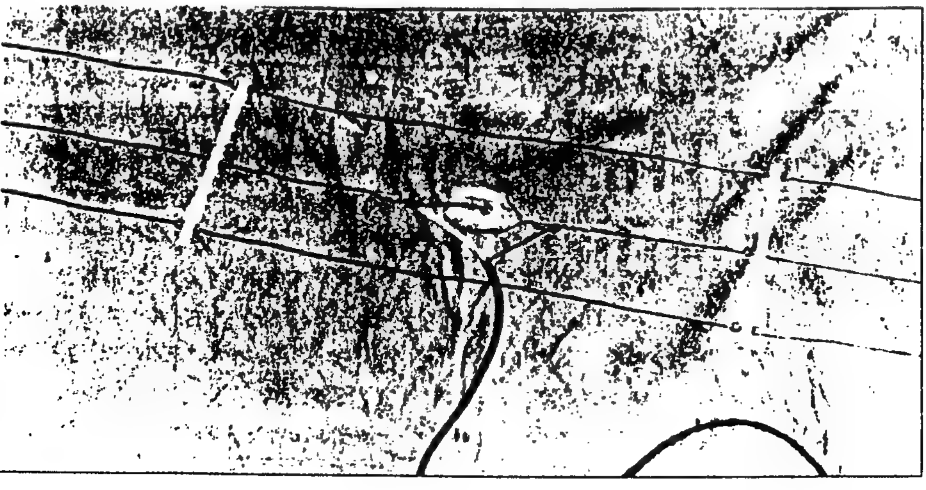


Fig. 7. Photo of the feedpoint region of the 3 frequency C-R antenna for 10.1, 18.1 and 24.9 MHz.

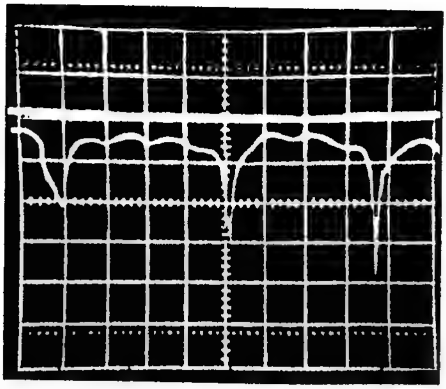


Fig. 8. Return loss sweep of the example 3 frequency antenna. The scales are 2 MHz/div. horizontal (18MHz center) and 10 dB/div. vertical.

The VE7ZM "California Board" 75M SSB QRP Transceiver

by Bruce Gellatly, VE7ZM
279 Rudyard Rd.
Victoria, BC
V9B 1K6 Canada

The building of a QRP transceiver in many cases could center on the sideband filter in the junk box rather than a recommended part in the latest write up in your favorite publication. The California Board is a compromise, and has been tested to produce from 1 to 2 watts output on 160, 75, 40, and 20 meters using 455 KHz, 5.1MHz, 9.0MHz or 12.7MHz filters. In a simple sideband rig a 455 KHz filter is ok on 160 or 75 meters but would not be satisfactory on 40 or 20 meters.

The 9.0 MHz filter has proven to be the most versatile for the bands listed. It is also easier to locate at the flea markets. [NOTE: 9MHz filters for this rig are available for $10 from NorCal QRP Club. These are the Showa 9 MHz filters and are very good SSB filters. Send $10 for each filter to: Jim Cates, WA6GER, 3241 Eastwood Rd., Sacramento, CA 95821. Make checks or money orders out to Jim Cates and not to NorCal. DX orders please add $3 for shipping.]

The California Board does not incorporate the oscillators, as the frequencies to be injected in the mixers are determined by the band of operation planned, and the sideband filter to be incorporated in the transceiver. The table illustrates in a few lines what has been tested and has produced QRP contacts.

Band	Filter	VFO Tuning	BFO Set	Coverage
160LSB	455KHz	2.253-2.453	453KHz.	18-2.0 MHz
75LSB	455KHz	4.2-4.45	453KHz	3.750 - 4.000MHz
40LSB	9.0MHz	1.7-1.850	9.0015MHz	7.150-7.300MHz
75LSB	9.0MHz	5.0-5.25	9.0015MHz	3.750-4.000MHz
20USB	9.0MHz	5.15-5.35	9.0015MHz	14.150-14.350MHz
40LSB	12.7MHz	5.4-5.55	12.7015MHz	7.150-7.300MHz

The filters used in the California Board came in various sizes, therefore no attempt was made to accommodate them as part of the PC board, but rather to attach the filter to

the back of the cabinet and using RG174, connect the leads to the circuit.

A review of the circuit shows a simple superhet receiver laid out on the rear of the board. The front of the board and one end is devoted to the transmitter function. A DPDT relay does the changeover from transmit to receive. One section of the relay changes a regulated 5 volts from the receiver to the transmitter function. The other section of the relay does the antenna changeover.

The VFO and BFO incorporates an independent voltage regulator and these oscillators run continuously. I have included as part of this article a circuit and PC board layout of the oscillators used here.

As a building project you will realize that where values of L/C are quoted they will put the transceiver on 75 meters. You will also appreciate that the filter employed was 9.0 MHz. In some of the construction for higher frequencies an additional stage of amplification was required in the form of a 2N2222A run class A, inserted between the NE602 and the VN10KM. This little amplifier is made up on perf board about the size of a postage stamp, and was broad banded (no tuned circuits). In the future, the California board will be modified to incorporate this additional amplification and to also provide AGC in the receiver section.

The fixed resistors are 1/4 watt and the electrolytic capacitors are radial .2" lead spacing. The frequency sensitive components in the VFO are axial poly and NPO. The relay is a Radio Shack 275-249 mounted in a 16 pin DIP socket. There are 5 two pin @ .1" spacing molex connectors and 1 - four pin @ .1" spacing molex connector to power the VFO-BFO. By putting these connectors on during the construction you will save time later on if the board is lifted from the cabinet for modification or repair. The choice of cabinet for the rig is yours, however a Radio Shack #270-272A, 1 15/16" x 8 1/4" x 6 1/8" is about the right size, and there is enough room left over for a 5 watt amplifier or frequency counter to be added later.

A note on T1 and T2. These are bifilar wound and are a bit confusing until you understand the concept. To do a bifilar winding, cut two pieces of #24 enamel wire 15" long. Burn the insulation back 1" from one end of each wire. Sand the wire with fine sand paper to remove the residue. You should have a nice shiny copper wire showing for 1".

Put the two stripped ends of wire in the chuck of a hand drill. Grab the other ends with a pair of pliers, and turn the drill slowly. You will twist the wires until they have about 7 or 8 turns per inch. Then wind the toroid with 9 turns, remembering that each time the wire passes through the center it is 1 turn. When you have 9 turns, take the wire and cut it so there is 1" of lead. Unwind one turn from the unstripped end, and strip both wires as you did before. Now the fun begins. Take your ohm meter and find the beginning and end of wire A. Mark it some way. Take the end of wire A and twist it together with the beginning of wire B. This is the tap of the bifilar winding. The other two ends of the wires, the beginning of wire A and the end of wire B are the start and finish of the coil.

Tune Up

If you have finished the placement of the parts and have good solder joints on all points, you are prepared for tune up.

Receiver:

1. Take your multimeter and read the resistance between 12V input and ground. A reading of about 500 ohms will show no shorts in the board, and would indicate "normal" for the receive position.
2. If you have a grid dipper, you can set the slug in coils L1 and L4 for say 3.85 MHz, or in Canada 3.75 MHz.
3. Hook up the speaker, antenna and power on the receiver. It should come to life. If not,

check that the VFO and BFO are operating. Set the BFO about 1.5KHz on the high side of the crystal filter frequency for LSB operation. The VFO should be operating in the range previously tabled in this article. Once you determine that the receiver section is working, make sure that the slug in L1 is set for optimum by peaking on a weak signal.

Transmitter:

1. Prior to the switching on of the transmitter section set both the trim pots for the VN10KM and IRF510 so that the center pin on the trim pots are at ground potential.
2. Make sure the antenna or a dummy load is connected to the board, an unloaded IRF510 will blow out in about 2 seconds.
3. Looking down on the board there are two metering positions, one for the VN10KM, which is to the right of the IRF510. The other to meter the IRF510 is at the right of the +12V pad input to the board. The jumper wires to bridge these points should be soldered in until the forward bias is adjusted.
4. Take a short piece of insulated wire and place it near coil L4, the other end of the wire is attached to your 75 meter receiver as an antenna input.
5. Close the Push to Talk switch and locate the signal on the 75 meter band. Peak the slug in L4 for best output. Talk into the mike and you should have clear audio on LSB. Switch off and disconnect the random wire pickup.
6. To adjust the VN10KM, connect your multi-meter across the meter points and set to read milliamperes.
7. Turn on the transmitter and slowly adjust the trim pot related to the VN10KM until the meter shows about 10 mils being drawn by the VN10KM. Switch off. Disconnect meter and solder in a jumper wire in place of the meter.
8. In similar fashion, put the meter in the IRF510 points and slowly adjust the other trim pot until about 18-20 mils is being drawn by the IRF510. Set the meter to read high current and talk on the mike. Voice peaks should be more than 300 mils. Listen to the audio on the receiver to make sure the transmitter is running linear, and the audio is clear and free of distortion. Solder in the jumper wire and tidy up for your on the air testing.

To monitor your rig you can set up an LED as VE7QK did in his 5 watt amplifier (December 1994 QRPp, p. 46) by sampling the RF at the antenna terminal, or in my own case I use a small meter (0-200uA) with a shunt so I can read 0-500 mA. I meter the board in total by placing this meter in the line between the switch on the back of the 1K pot and the +12V pad on the board. The other side of the switch is connect to your power source. This makes an on-off switch for the rig.

Placement of the VFO/BFO board should be as far removed from the transmitter tank coils as is practical. RF feedback to the VFO will show up as FM distortion and may cause you to make up shields to eliminate the problem. Good luck with your QRP SSB rig.

If you decide to build this project, just plug in the soldering iron and get going. If you decide to wait while others do the experimenting, you have missed out on a lot of fun. I have built 3 of these rigs, all different and not one came out without some trouble shooting. But once adjusted and tuned up they are reliable and fun to operate on 160, 75 or 40 meters. This transceiver is the product of over 4 years of development by the members of the B.C. QRP Club with significant input from VE7QK, VE7TX, VE7YY and of course Doug DeMaw, W1FB for the VFO.

This story would not be complete until I expressed my thanks to AB6EY who used his CAD program to create the California Board. Dick resides in Granite Bay, California, thus the name "California Board". 72, Bruce, VE7ZM

"California Board Parts List"

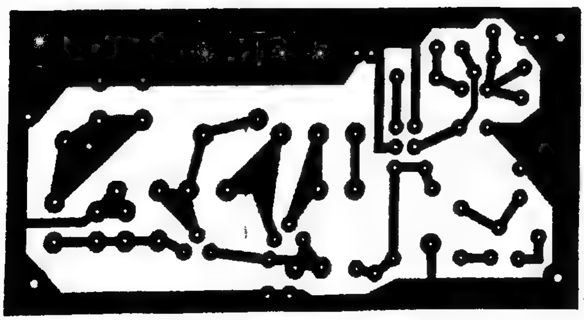
C1,8 100uF

C2,7,11,28,31,33,38	22uF/25V
C3,9,10,10A,14,21,22,32,32A,34,35, 36,	.01uF
C4,5,24,25,26,27,29,37,43	.1uF
C6, 39	.001uF
C12	47pF
C13,30	270pF
C18, 20	680pF
C19	1500pF
C23	330uF/25V
C15,42	56pF
C16,17	.005uF
C41	4.7uF/25V
R1, 3, 4, 9, 10, 13	100 ohm
R2	1 ohm
R5	47 ohm
R6, 8	10K3/8"10T tmpt
R7, 14, 15	10K
R11	470 ohm
R12	27K
R16	1K
R17	1K Pot/w switch mounted on chassis
U1	LM386-1
U2, 3, 4, 5	NE602AN
U6	LM741
U7	7805
Q1	VN10KM
Q2	IRF510, 511, 520, 521, 530, 531
L1	30T Primary, 2 T Secondary #28 on 1/4" x 3/4" slug tuned coil form
L2, 3	19T #26 on T50-2
L4	30T #28 on 1/4" x 3/4" slug tuned coil form
T1, T2	9T #24 Bifilar on FT50-43
J1	BNC ante. con.
J2	Power connector
J3	Headphone Jack
J4	PTT Switch
J5	Microphone Jack
FL1	9.000MHz SSB Filter (Showa)
PL1, 2, 3, 4	Molex female plug 2 pin .1" spacing

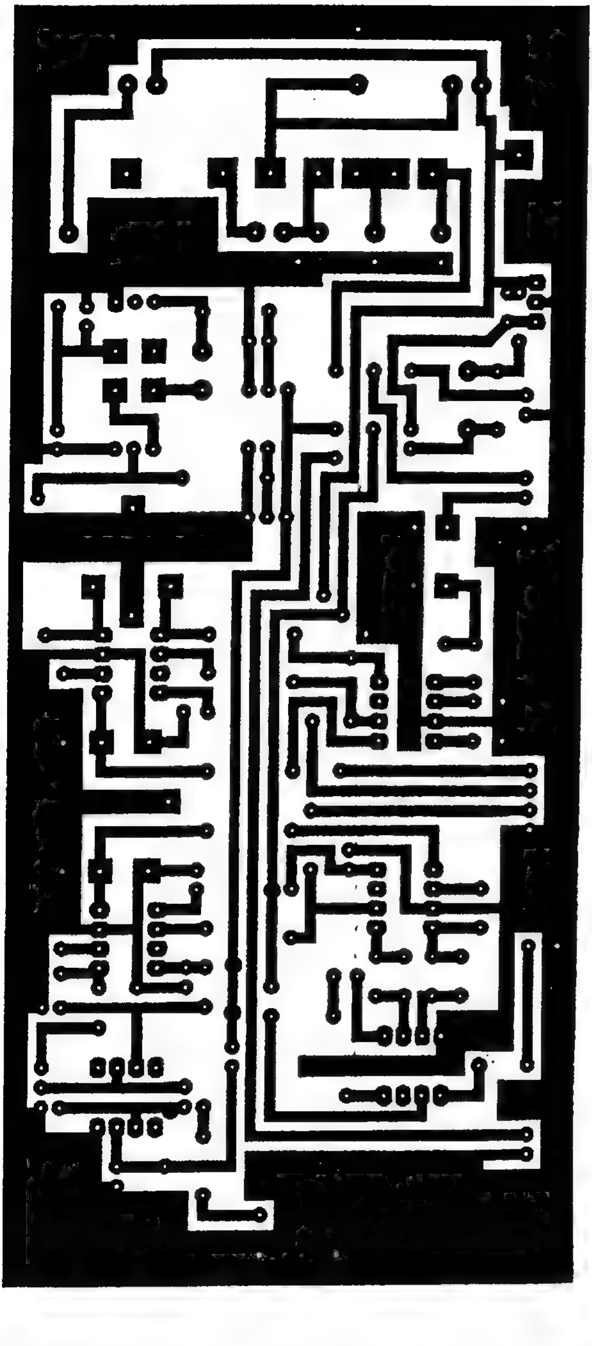
PL5	Molex female plug 4 pin .1" spacing
P1, 2, 3, 4	2 pin .1" spacing header
P5	4 pin .1" spacing header

BFO/VFO "California Board SSB Transceiver" (75M)
Parts List

C1, 5, 6, 11	100pF
C2	25pF Trim Cap
C3	15pF Air Variable
C4	22pF
C7, 8	56pF
C9	6-60pF Trim Cap
C10	25pF
C12, 13	.1uF
R1, 4, 5	100K
R2	220 ohm
R3	270 ohm
R6	100 ohm
R7	330 ohm
Q1, 2, 3	MPF102
VR1	78L08
D1	8.2V Zener
D2	1N914
L1	36T #24 on T68-6 (yellow)
RFC1, 2	1mH choke
XL1	9.0015 MHz crystal

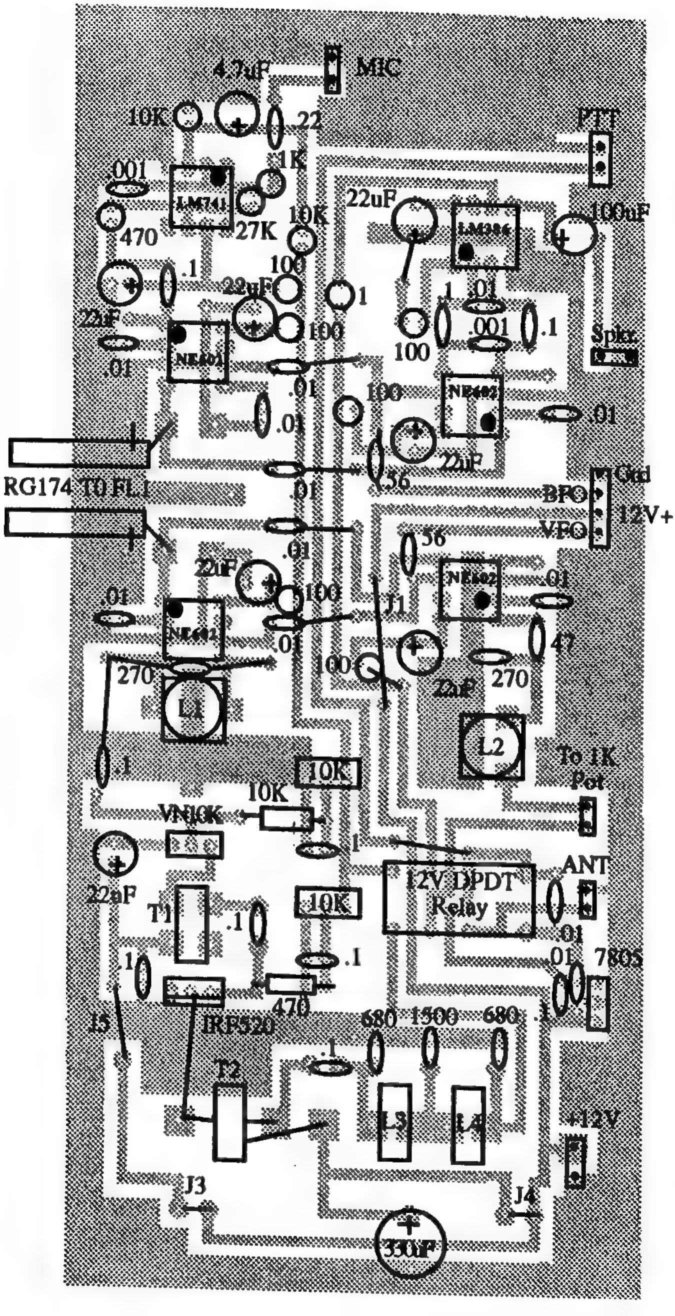


Actual size of VFO-BFO board. Foil side view.

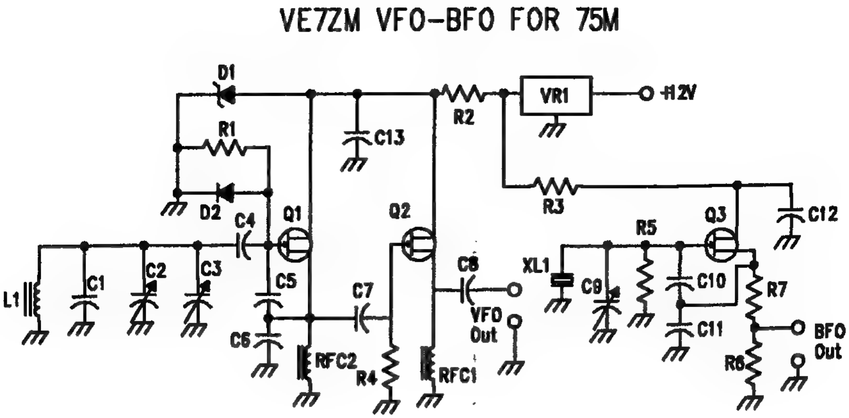


Full Sized PC Board Pattern for VE7ZM "California Board" SSB Transceiver. View from foil side.

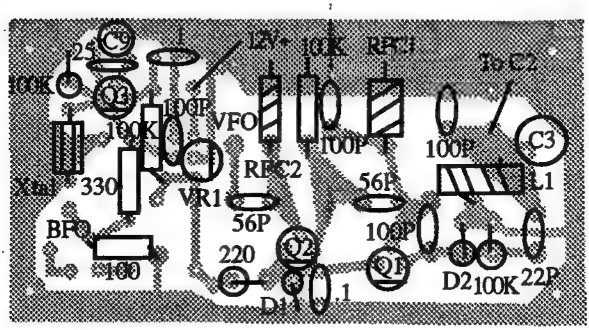
PC Boards are available for this project from FAR Circuits, 18N640 Field Ct., Dundee, IL 60118. The California Board and VFO set of 2 boards are $12 + $1.50 postage.



Parts Placement Guide for VE7ZM "California Board"

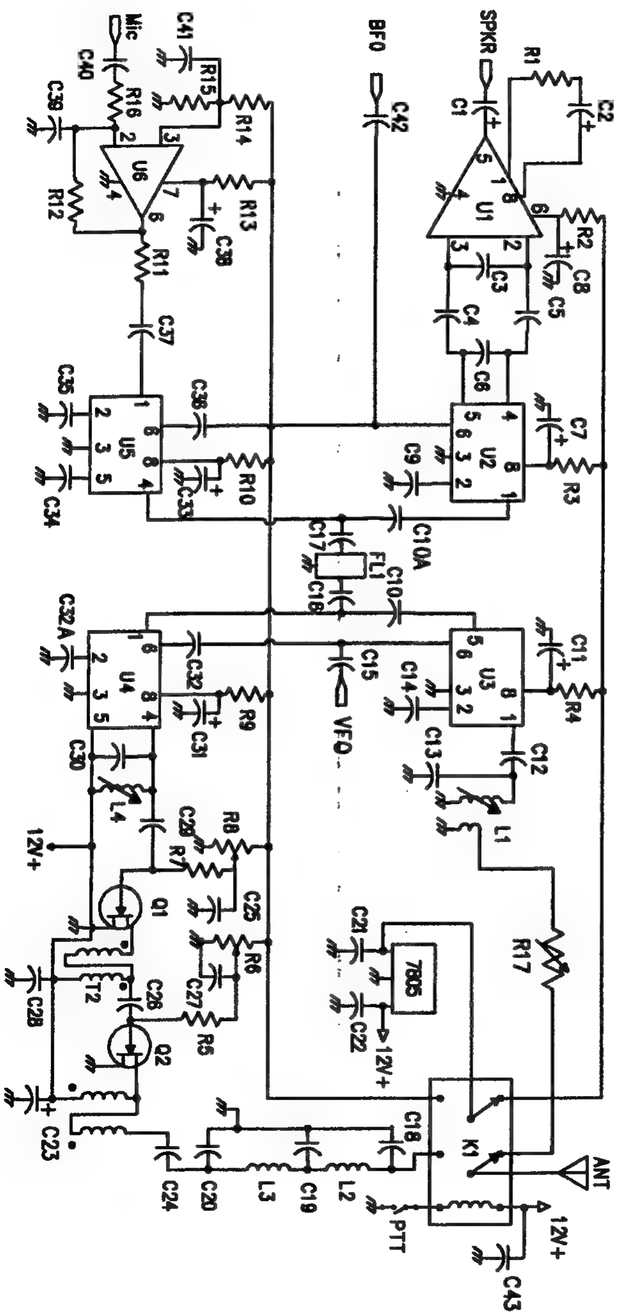


Schematic for VE7ZM VFO-BFO Board for "California Board" SSB Transceiver



Parts Placement for VFO-BFO Board

VE7ZM "California Board" SSB Transceiver



The Neomyte: VE7TX Cigarette Package 80M SSB Transceiver

by Joe Stivec, VE7TX
13852 Marine Dr.
White Rock, British Columbia V4B 1A4

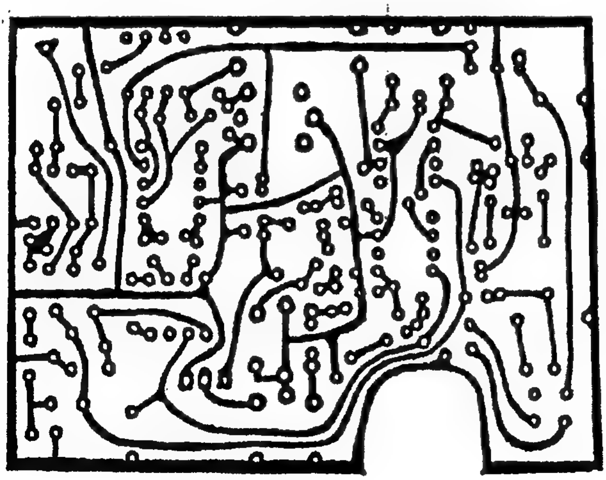
[Editor's Note: This is the rig that appeared in December 91 QST in the "Up Front in QST" section. Many hams have asked Joe to write up the rig, and he agreed to do so for QRPp. It fits in a Canadian cigarette box, and I have talked with the rig from my home QTH in Dos Palos, California to Joe's in White Rock, BC. It is the same rig that I had and demonstrated at the Pacificon Convention in October of 1994. Jpe has built two of these rigs, and he says that they are reproducible from the information he provides here. This article is a construction article, but it is not for the faint of heart. There are no commercially available boards, you will have to make your own. This is a "Home Brew" project in the truest sense of the word. Doug, KI6DS]

A good antenna is a must. The bigger the better. It works well with a delta loop, inverted V or a dipole. It must be resonant and well matched. You must be careful with the antenna matching, or you will suck the final chip up the coax.

A twelve volt power source such as a twelve volt gel-cell or car battery is best. The rig also works well with nicads or dry cells. The drain is about fifteen mils on receive and 140 mils on peaks on transmit.

It is essential to have a good speaker of 4 - 8 ohms. I use an 8 or 10 incho oval here and it gives plenty of audio to fill a big rooom. On real weak signals a little more audio would be nice but in that case I use earphones and I usually can't talk to them anyway unless they have a lousy antenna.

The microphone is built in and is located at the far right of the front panel. I speak 12 to 16 inches away although it seems to pick up okay 3 to 4 feet away. The output meter should hit full scale on peaks. It is in the antenna output circuit and measures the antenna current going up the wire. Here is the schematic for the rig, parts list, and a foil side view of the pc board pattern. Good luck. 72, Joe, VE7TX.



Full Size PC Board Pattern For VE7TX Neomyte 80 Meter SSB Transceiver

A Sierra Takes on the Alps

by Cam Hartford, N6GA
1959 Bridgeport Ave.
Claremont, CA 91711

It must have been the look on my face that did it. A wistful, longing, far away detachment that signaled some conflict to my wife's perceptive eye. We were planning our 25th Wedding anniversary trip to Europe, something we had been anticipating eagerly for several years. A truly joyous occasion such as this should not be approached with melancholy. "What's the matter?" she asked, innocently enough.

"I realize that the time frame for the trip is limited by our work schedules, but this means that I will be missing Field Day. I have never missed Field Day. Not since that first time I discovered it, almost 20 years ago, have I ever missed Field Day.'

She is such a jewel. Realizing how much Field Day means to me (and also realizing how much going to Europe means to herself) she offered a conciliatory thought: "Maybe you could take one of your radios and operate it over there."

Voila. The hard part was over.

Now comes the easy part. We were going to go to Switzerland for three weeks, to stay in a rental apartment in a chalet, and ride the rails, boats, busses, chairlifts, gondolas and whatever other means of conveyance those clever Swiss had contrived. There was no way to know what the prospects for antenna-raising were at our apartment, but I was sure I would at least be able to backpack a rig up into the hills for some HB9/N6GA outings.

Doug Hendricks, KI6DS, very generously offered his own prototype Sierra for the trip. I was planning on taking my NorCal 40 because of it's small size, low power consumption, etc., but the thought of having all of those bands to use was irresistable. And the Sierra was only slightly larger and more power hungry than the NC 40. Before leaving I had just enough time to build and install the Oak Hills Curtis keyer kit into the rig. What a neat package it made.

Many bands and unknown antenna possibilities made it imperative that I had a tuner along, so with the help of Charlie, W6JJZ, I transformed a blank NC40 case into a multiband tuner with SWR bridge built in. Now the station was taking shape. I added a 1.2 AH gel cell and a small 50 mA solar panel for power, and about 400 feet of #28 stranded black PVC covered wire for unobtrusive antenna work. all this had to fit in the one suitcase and one carry-on I had allowed myself, along with all my clothes and other essentials. We were determined to travel light, and I believe this must have been one of the lightest multiband stations, complete with power source and antenna ever assembled.

Obtaining the reciprocal license was a breeze. The ARRL supplied the correct form, I supplied the money, and about three weeks later I received my license. The hard part was using it -- the call, that is. It took some practice to get used to inserting the HB9/ in front of my call.

Arrival in our new temporary home was a real eye-opener. All of the pictures and movies and travelogues just can't prepare you for the real thing. After an 11 hour plane ride, the sight of land, any land, is very welcome, but this was exceptional. The 2 hour train ride from Zurich to our temporary home town started out in gently rolling terrain, green farmland that is reminiscent of many locations in this country. But the rugged, snow-covered peaks started growing on the horizon. The train began climbing and passing through tunnels, so that each time we emerged, we were closer to those peaks, until we emerged from the last tunnel into our home town of Kandersteg. What a spectacular setting! Try to imagine the floor of Yosemite Valley as a brilliant green pasture, El Capitan and Halfdome towering above, but with the snow-covered peaks of the high Sierra brought

in tight behind. It was an artist's dream.

But, it was a DXers nightmare. This gorgeous little village was nestled in a valley with a 45 degree horizon all around, except to the Northeast, where it was more like 60 degrees! So much for the low angle of radiation. I'd have to make good with the locals.

Our home away from home turned out to be in a gorgeous chalet, although the apartment was on the ground floor, part of which was basement. Fortunately, the place was surrounded by trees, so I was able to get up an end-fed wire about 60 feet long, the farthest end being about 25 feet off the ground. The low height was probably a blessing in this location, as it probably helped boost the signal up and out of the valley.

It was also helpful that our landlord and his wife were happy to accommodate my quirky needs. They rent out the apartment year round, to hikers in the summer and skiers in the winter, and no doubt have come across some odd renters with strange habits. But the they were only too happy to play along, to the extent that he offered to help me put up the antenna. It turns out that he was quite fascinated with the idea, and was eager to see the radio and witness it being operated. Each night after coming home from work he was anxious to hear who I had been able to contact since our last conversation. On a few occasions that meant having to settle into their living room for an evening of conversation, some homemade Swiss baked goods, and perhaps a bottle of the local Rhine wine. Of course it was time I could have well spent chasing DX, but hey, we did our part for international relations.

The little tuner was able to load up the antenna on all bands, even thought it was looking into some pretty strange impedances. 80 meters was pretty tough because of the high QRN level. We had thunderstorms on the mountain peaks almost every night, so I did little operating there. 20 meters was pretty much of a washout because of the local geography. 30 meters proved to be quite useful, but there are many more commercial stations sharing the band, so the holes for hams are few. 40 turned out to be the mainstay. Since we were around mainly in the evenings, it turned out to be quite a good testbed for the Sierra as well.

One thing that worried me some before the trip was the bad press the NE602 had received regarding it's poor intermod and strong-signal handling capabilities. More than one article had inferred that an NE602 based receiver just would not play in Europe on 40 at night. Thanks to Wayne, N6KR, it was not a problem. He placed an RF pot ahead of the first mixer chip, and it is that attenuator that makes the big difference.

40 meters is as bad as they say it is. The foreign broadcasters which we hear but are able to ignore here on the West Coast are not foreign over there. They are plentiful and they are strong, and the result is lots of RF in your front end. Most evenings on 40 meters I had to run the RF pot at about half scale, sometimes evendown to a third. A signal which was clearly readable with the RF gain set low would slowly disappear under an increasing blanket of hash as you increased the gain. At full throttle there wasn't much that was readable, just a big pile of mix and overload products. But to the credit of the Sierra's design, most of my contacts were on 40 in the evenings.

A final tally showed 16 countries worked, most of which would really be tough to work from home. Best DX came on a Sunday morning during the IARU Championships, when I managed to snare a W3 from Delaware. The signal must have slipped out of the neighborhood through a small gap in the mountains to the Northwest.

Being a gringo in a foreign country does have its benefits. Most of my CQs were answered immediately, and I spent most of my time answering questions about who and where I was, and what I was running. It was especially fun to work the QRPers, who were plentiful. I exchanged ARCI numbers with several of them, and after a helpful PA3ALX looked up my G-QRP number for me (I had forgotten it) I exchanged that number with

several others. I was grilled about the Sierra quite regularly. One of the more surprising contacts I had was with a PA3 who, when I had concluded a description of the rig, returned with the comment, "That sounds like the Sierra."!!!! You must realize that this happened in early July, when most of the free world had not yet heard of this project. it turns out that his copy of Sprat had recently arrived, and he had just finished reading a description of the rig which appeared therein. He was as surprised as I was to hear one on the air, and on the Continent, no less.

Enough of this writing business. My own Sierra kit arrived today, so I have better things to do than jaw about the rig and the travels. As I discovered, it does travel well, and will make a fine companion on the many backpacking and Field Day trips to come. If I get lucky, this one might someday be able to retrace the footprints of it's prototype ancestor, a job for which it is well suited.

72, Cam

Mobile CW: Keep it Simple

by Monte Stark, KU7Y
285 W. 4th St.
Sun Valley, NV 89433

I always like to keep things simple. Maybe that's why I like CW. When I decided to go mobile the first thing needed was the antenna. There was a local store here in Reno at that time so I bought what they had. A Hustler. Got the loading coils for 40, 30 and 20. Used a bumper mount on the old 72 Chrysler. Only needed one hole in the back. XYL will never notice, right?

So far, so good. All that was lacking was a radio. After looking around the internet awhile I found a TS 130 S. Got that and still kept the xyl! But after 36 years, she is getting used to me. (I think).

Now to run some wire around from the battery. No trouble there. Oops, I put the power strip in the only place in the whole car that Carol uses for her feet. Oh well, it's really not that hard to move.

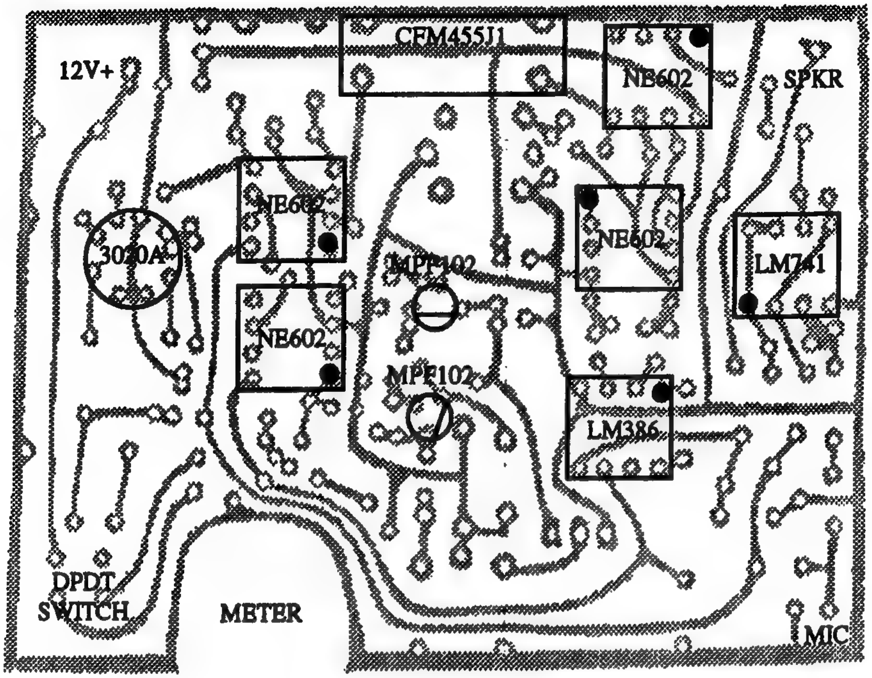
Now to put the radio in the car. WHAT? No mount? Oh, no problem, just cut, bend and weld up a bracket to hold the radio. (Sure glad we have a large shop at work that I can use). OK, mount the radio. Wow, I didn't think it would take THAT long for the paint to dry. Lets see now, what else? A key! After digging around in the boxes of "stuff" I found my old MFJ keyer with a single lever paddle built in. Still works. A little more digging yielded a patch cord.

Turned it on and it worked. Tuned the antenna and was ready for all the fun. Even put the 3 band plate on the antenna and mounted all the coils. Of course I had to guy the mast to the car roof. Carol really "liked" that. But we were about ready to leave to see some of the grand kids in Idaho so I won for the time being. Had to hold the keyer against my leg with my middle finger while using the thumb and index finger to send. Who said you have to spend a lot of money to have fun?

Had lots of fun, but couldn't help but think that there must be a better way. Then I got a 1 ton 4X4 diesel pick-up truck. Went through the "invent a radio mounting bracket" all over again. Even let the paint dry this time! Mounted the antenna on the tool box . That was easy. Even guyed it. (It's my truck). Then I got smart and found one of those little plastic things that hold a couple of soda pop cans and has a couple of holes for what ever.

I mounted the keyer vertically to the front edge of the can holder. Boy, what a nice way to send. And the whole plastic thing comes right out if the seat space is needed. But the radio was right on top of the transfer case shift lever. Every time I put the truck into 4

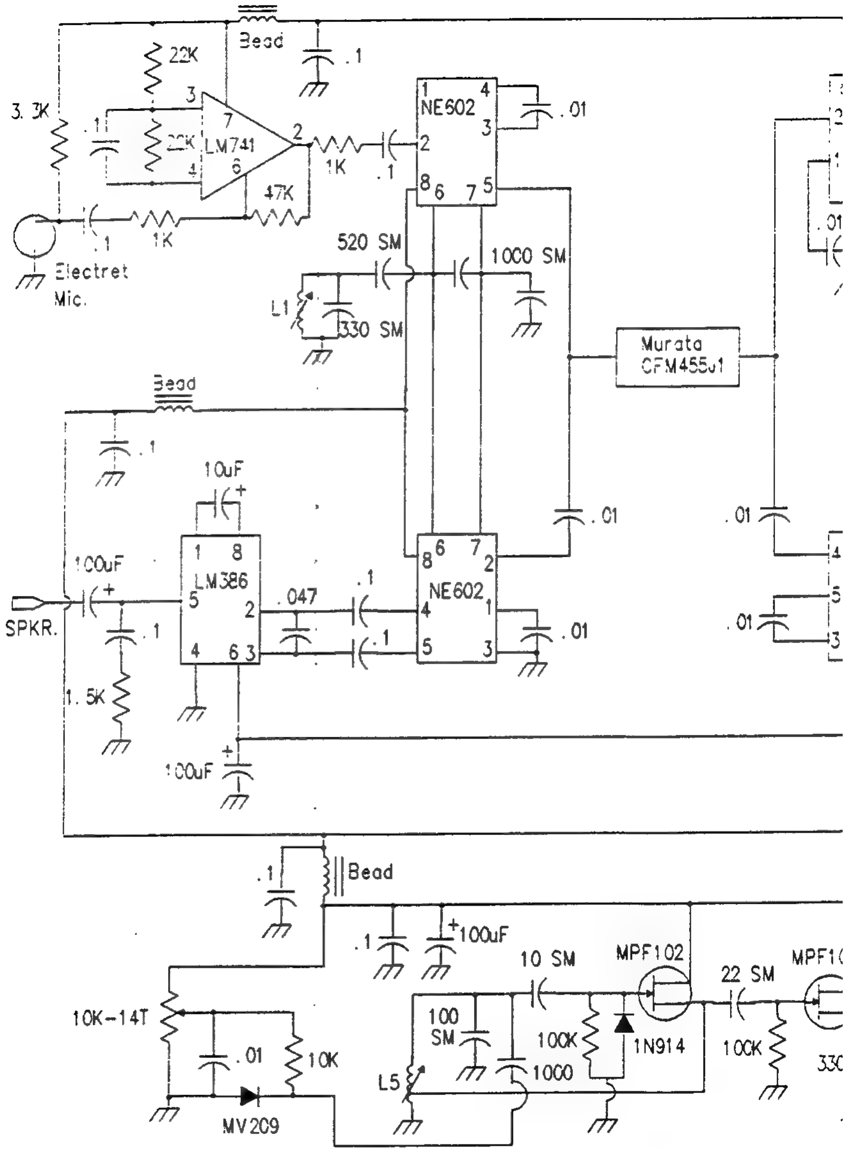
VE7TX Neomyte 75M SSB Transceiver Parts Overlay

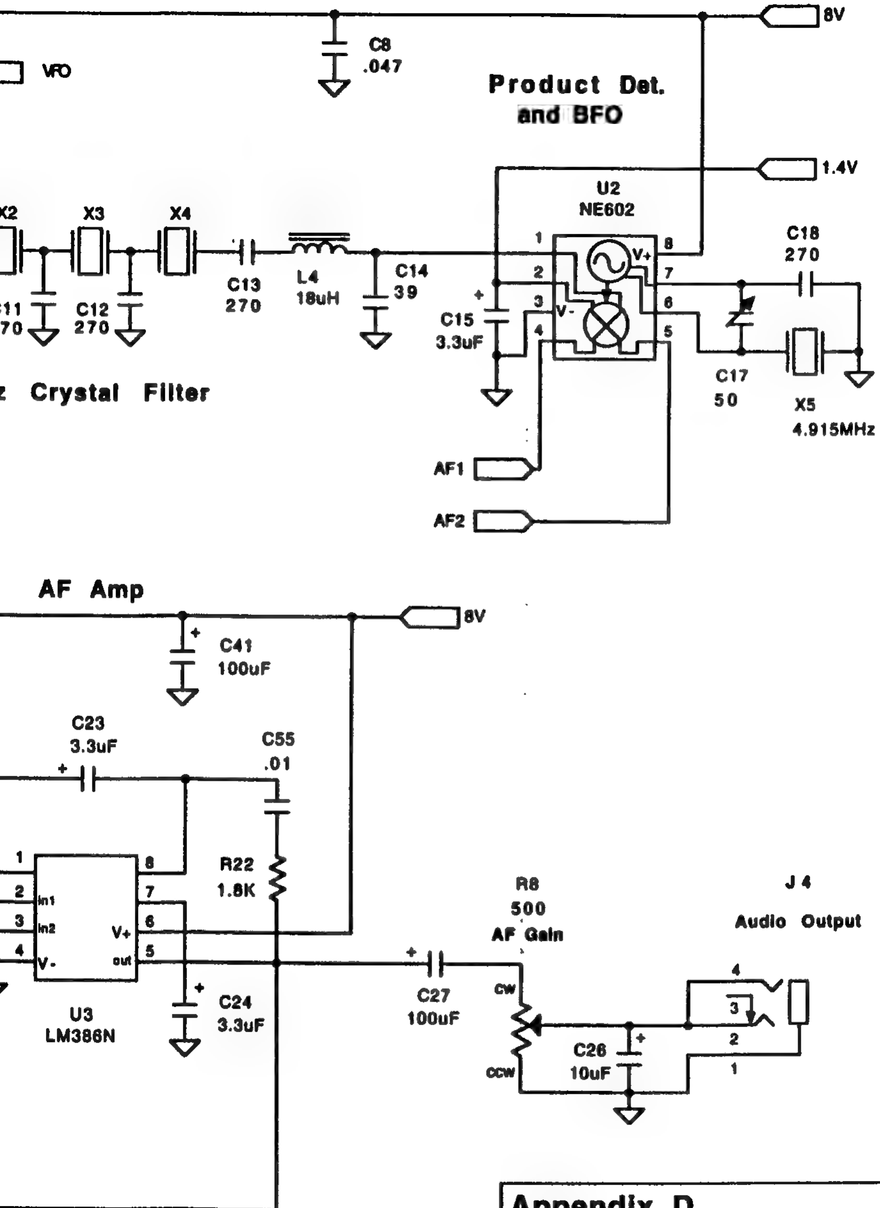


This parts diagram is by no means complete. I owe an explanation to the readers of QRPp. Joe Stivec is an MD and is a very busy man. I asked him for a parts placement diagram, and he is doing one now from the above artwork. It will have all of the parts and will be in the next issue. Due to time constraints and deadlines, there just wasn't time for Joe to get the information to me. I promised several people that this article would be in this issue, so I made the decision to go with what I have. PLEASE don't be critical of Joe, he very graciously agreed to provide the circuit and the information that is here. I will have the complete parts overlay in the next issue, I promise.

The VE7TX Neomyte, the VE7ZM "Californa Board", and the previously published article on the VE7QK Epiphyte series of 75M SSB transceivers are all the result of hundreds of hours of experimentation by the British Columbia SSB QRP group. They have been building and testing SSB rigs for years. I am in their debt for allowing me to publish the fruits of their labors. All of these rigs are used daily on local QRP nets, and it is not unusual for me to talk with them on a nightly sked that we have. We try QRP first, and if we can't make it, we go to QRO (100 Watts). I am about 1000 miles south of BC, and can attest to the fact that these rigs do work. They are fun to build, and even more fun to operate.

VE7TX NEOMYTE



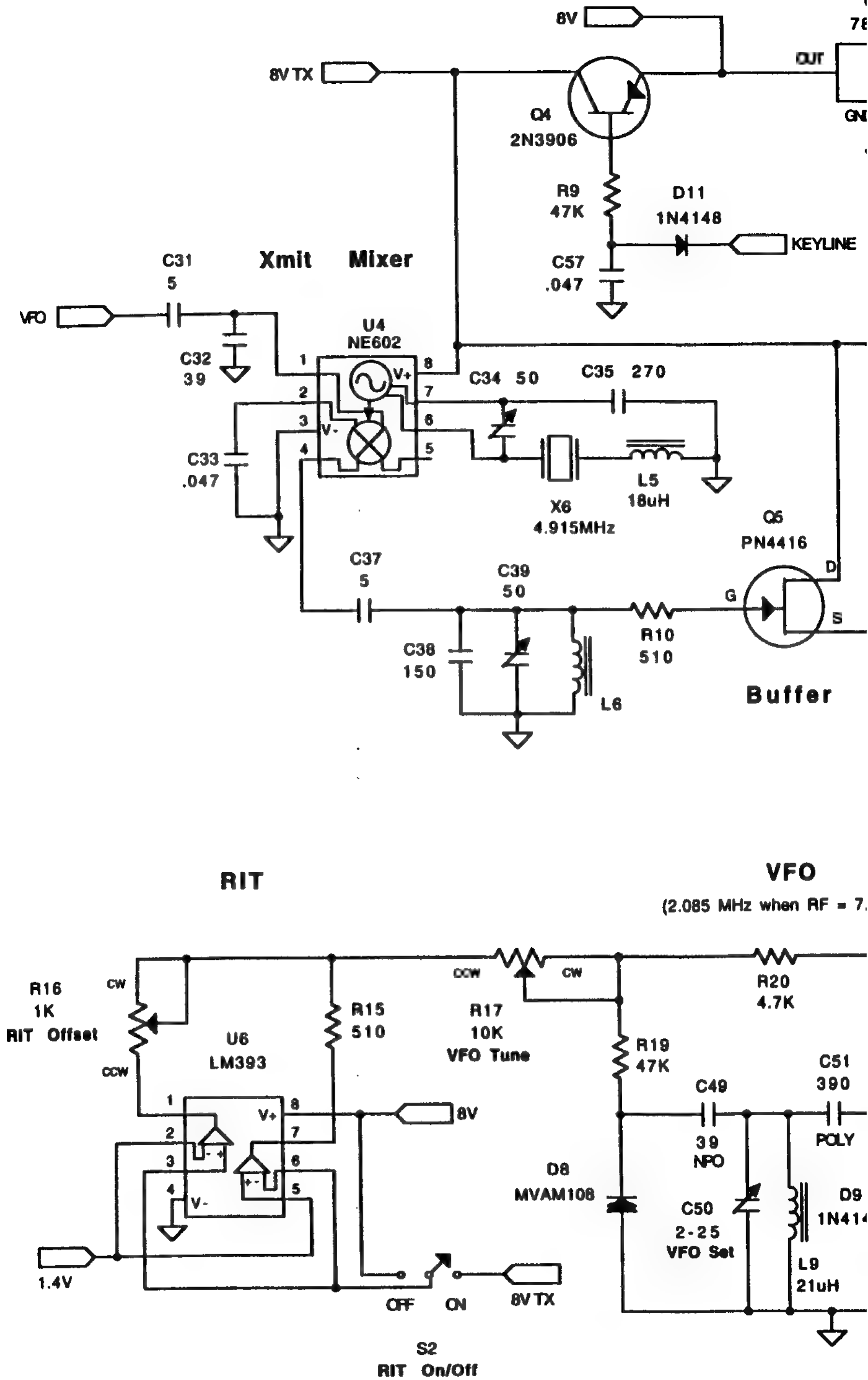


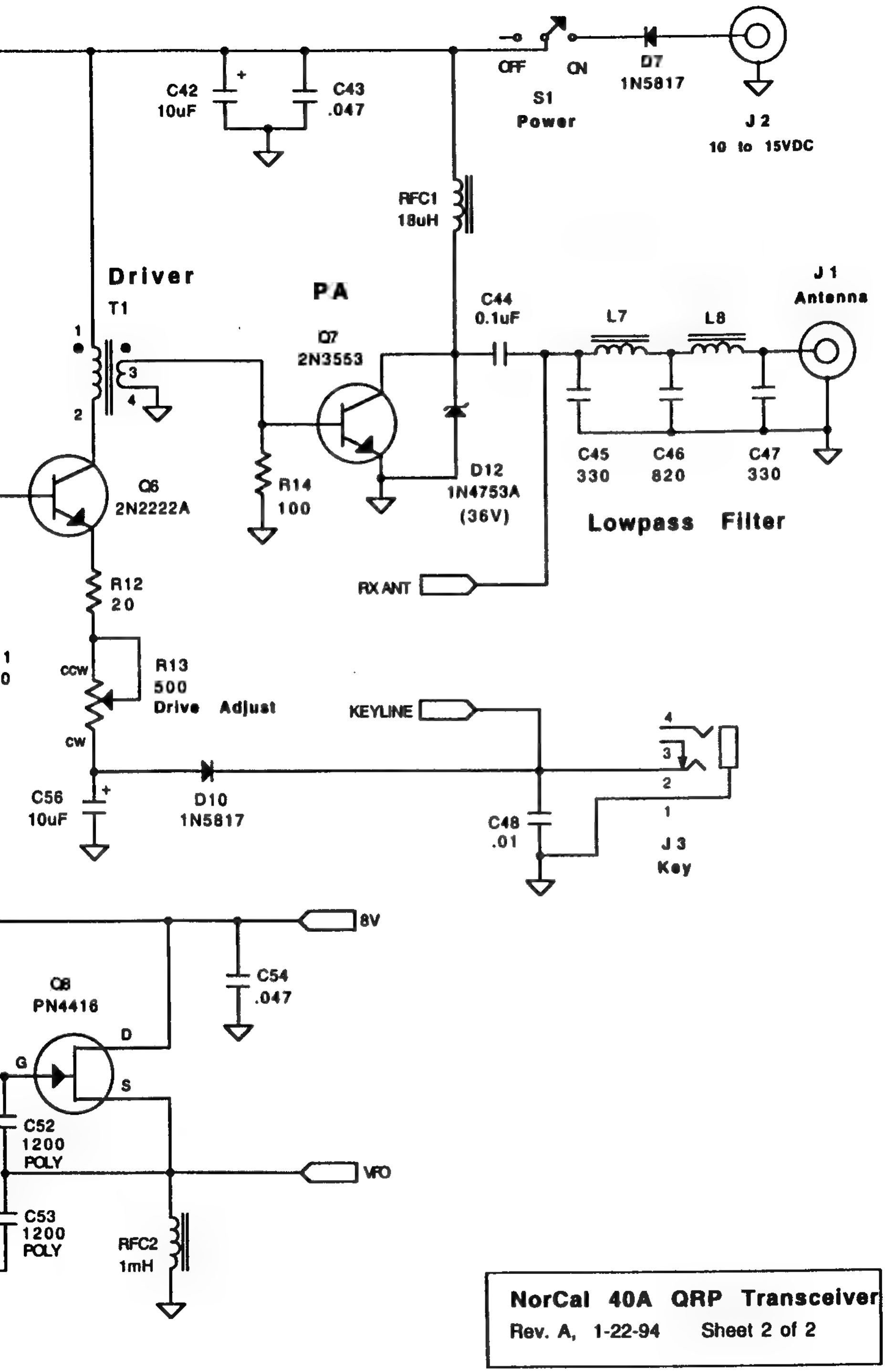
Appendix D

NorCal 40A QRP Transceiver

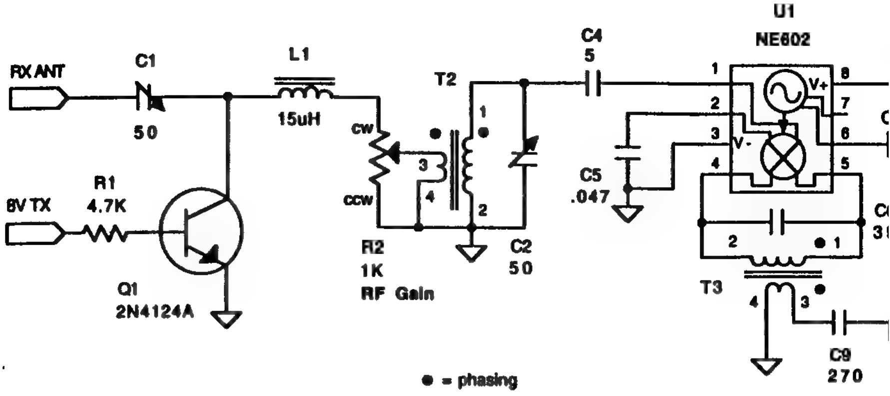
Wayne Burdick, N6KR

Rev. A, 1-22-94 Sheet 1 of 2

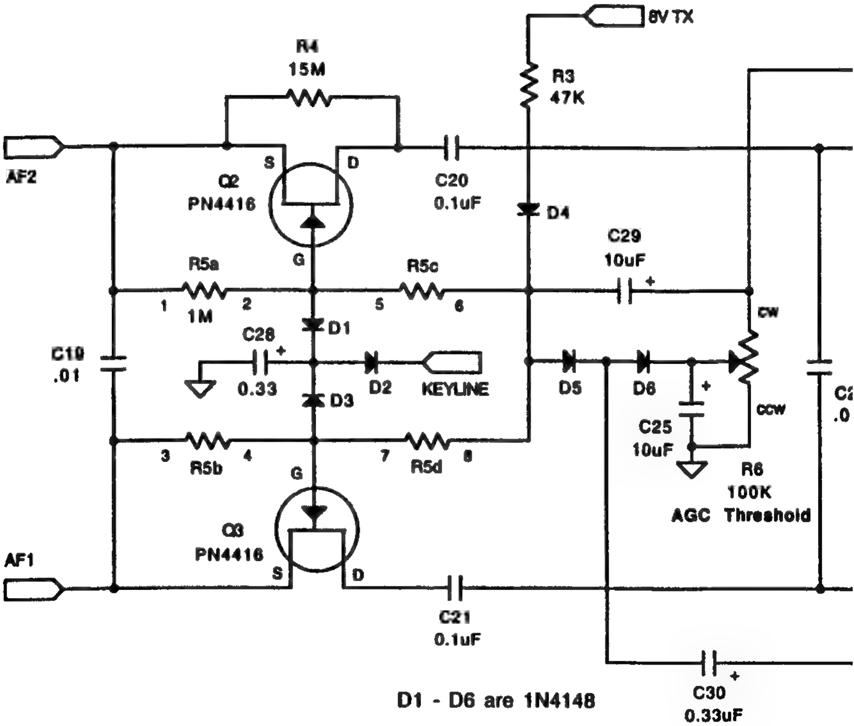

8V
8V TX
OUT
GND
Q4
2N3906
R9
47K
D11
1N4148
KEYLINE
C57
.047
C31
5
Xmit
Mixer
VFO
C32
39
U4
NE602
V+
V-
C33
.047
C34 50
C35 270
X6
4.915MHz
L5
18uH
Q5
PN4416
D
G
S
C37
5
C39
50
C38
150
R10
510
L6
Buffer
RIT
VFO
R16
1K
RIT Offset
CW
CCW
R15
510
R17
10K
VFO Tune
R20
4.7K
U6
LM393
R19
47K
C49
39
NPO
C51
390
POLY
D8
MVAM108
C50
2-25
VFO Set
L9
21uH
1.4V
OFF
ON
8V TX
S2
RIT On/Off


OFF
ON
S1
Power
D7
1N5817
J 2
10 to 15VDC
C42
10uF
C43
.047
RFC1
18uH
Driver
T1
PA
Q7
2N3553
C44
0.1uF
L7
L8
J 1
Antenna
C45
330
C46
820
C47
330
Lowpass Filter
Q6
2N2222A
R14
100
D12
1N4753A
(36V)
RX ANT
R12
20
R13
500
Drive Adjust
CCW
CW
KEYLINE
C56
10uF
D10
1N5817
C48
.01
J 3
Key
8V
C54
.047
Q8
PN4416
C52
1200
POLY
C53
1200
POLY
VFO
RFC2
1mH
NorCal 40A QRP Transceiver
Rev. A, 1-22-94 Sheet 2 of 2

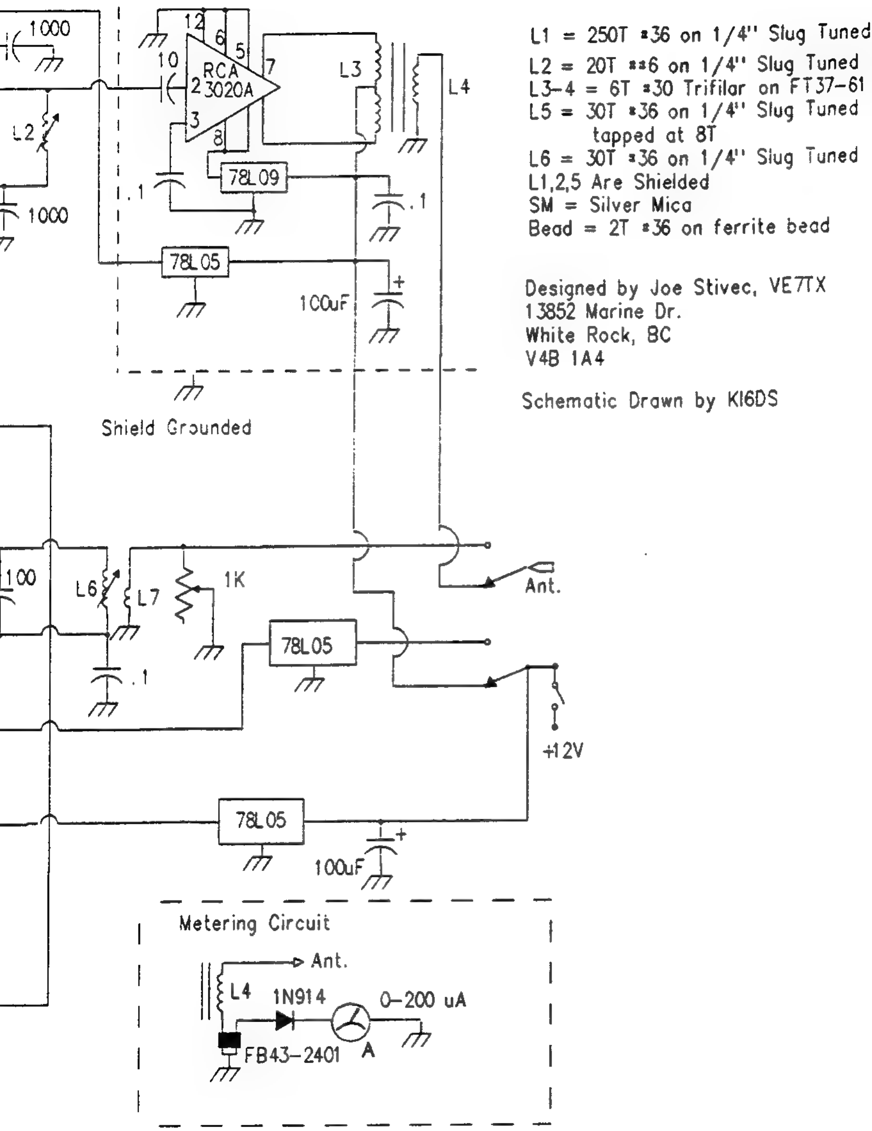
Rcv Bandpass Filter   Rcv Mixer

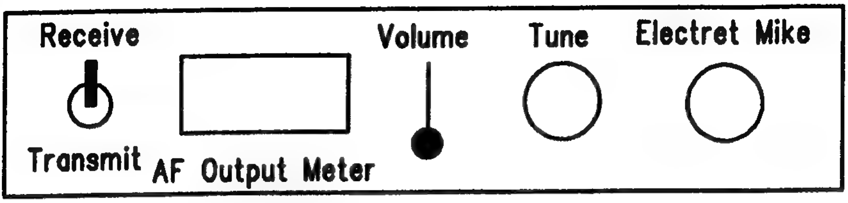


AGC/Mute

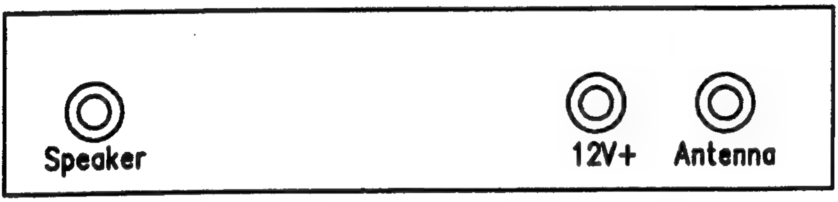


B TRANSCEIVER





VE7TX Neomyte Front Panel Controls and Layout



VE7TX Neomyte Back Panel Connectors and Layout

You will note that the panel arrangement shown above is the one that Joe used for the original Neomyte. The meter was from an old tape recorder. When I asked Joe where he got it, he smiled and said that it came from his "Junk" box. The volume control is a trim pot that has a map pin stuck into the "wheel" and extended through the panel. It is quite ingenious and works very well.

If you don't have a meter that will fit (and I will be quite surprised if you do), you may mount an LED and use the method that Derry Spittle, VE7QK, used to monitor the RF current in the Epiphyte Amp (QRPp, Dec. 94). The connectors that Joe uses are RCA, but there is room for a BNC. The front and rear panels are made of thin brass stock, and I think that Joe said that he got it at a hobby store. The panels are solder to the front and back edges of the pc board, and the rest of the "cabinet" is the cigarette box.

wheel drive, I cut my hand on the bottom of the radio! And the mounting bracket let the radio bounce all over. Ugh. What happened to the idea of keeping it simple?

Well now, what to do? Hum, I think I may have solved the problem. At least it's not so much work to do.

Put the 130 back into the house. Looked around the internet and found a MFJ9040. (Yea, I know. Make it myself etc. I got the NorCal40 Mini kit awhile back, but haven't located all the parts yet. So I just spent some of that dirty old money).In a few days I had the radio. It fits in the little plastic can thing. Get the power from the cigarette lighter plug. (If I'm driving on a nice paved road I put the radio up on the dash where I can see the dial better). The MFJ keyer has been replaced by an old Heathkit keyer with built in iambic paddles given to me by KA7T. It too is mounted vertically to the front of that plastic can holder thing. When I build my new keyer I'll put the memory keyer in the truck.

So if you want to give mobile a try, you can do it without most of the hassle of the big rig installations. There are even some good mag mounts available that will handle the large hf antennas so you don't even need to drill any holes. Now I know that all the QRO folks would laugh at a 5w mobile but all you QRPers should have faith. I seem to be able to do about the same with the 5w as I did with the 50w that I used with the 130. And I can unplug the whole thing and have it back in the house in a flash. Takes longer to undo the PL239 than anything else.

Complaints? Well, if your route takes you near many power lines, you may want to design a good noise blanker for whatever rig you use. (Hey Inet radio design team, listen up).Or just listen harder! After all, come this winter when you are digging for that weak one on 160 you will appreciate the help! (Just remember while you are driving with a hand over the ear phone trying to tell the noise from a dot or dash, DON'T close your eyes!) Listen for me near 7040 on my way to work in the am. (Around 06:45 PAST).

Above all, try it and have fun. 73's & cul, Ron, KU7Y

SW Broadcast Images on NorCal40

Ed Burke, KI7KW
28 Del Prado
Lake Oswego, Or 97035

Most of us who have worked the 40 meter novice sub-band have grumbled about the powerful short wave broadcast signals every 5 Khz above 7.100 Mhz.

I recently completed my new NorCal40 (original version, not "40A"), and was surprised to hear SW stations from 7.075 to 7.095 Mhz on my new rig after I had completed the modification to expand the tuning range to 150 Khz. I was quite sure that there were no such stations in that portion of the bend. So what was going on?

My first impression was that the phantom station that I was hearing at 7.075 (for instance) was really at about 2.755 Mhz (7.075 minus 4.915 equals 2.160, so the VFO must be at 2.160, then 4.915 minus 2.160 equals 2.755 Mhz). I ran this inspiration past Wayne Burdick, who kindly explained that the receive bandpass filter would do a good job of attenuating signals at 2.755 Mhz, and that the problem was more likely related to odd-numbered harmonics from the VFO.

When I listened to my new rig (which, by the way otherwise performed beautifully) I noticed another clue which supports the VFO harmonic hypothesis. When you tune an AM station with a CW receiver, the carrier is prominently audible; as the tuning is changed, the note sweeps through a range of frequencies, from about dc to maybe 800 Hz until it fades out. But my phantom images tuned much more sharply, in the sense that the audible frequency changed more for a given rotation of the knob. This, I realized, was a very strong indication that what I was hearing was related to harmonics. When the VFO is

tuned from 2.160 to 2.170, for instance, the fifth harmonic changes 50 Khz for the fundamental's change of 10.

Wayne had suggested that I experiment with a low-pass filter at pin 6 of the receive mixer. To make a longer story short, I was able to confirm that my phantom SW broadcast stations were showing up courtesy of the fifth harmonic of the VFO. Assume that the station is heard at 7.085, so the VFO is 2.170 Mhz. So the fifth harmonic is at 10.850, and a station at 5.935 Mhz would be hetrodyned to 4.915 and would go right through the crystal filter and be heard! Note also that the receive bandpass filter would not be able to reject RF energy at 5.935 Mhz as it would a lower frequency since it is centered at 7.050 Mhz.

In a way this is good news. The fifth harmonic is easier to deal with than the third, and so on; the separation of the two frequencies makes it possible to use a simple R-C low pass filter effectively. You get 6 db per octave with this topology, an octave is a frequency doubling, and there are more than two doublings from 2.170 Mhz to 10.850 Mhz, so we can expect better than 12 db of attenuation.

I added a low pass filter consisting of a 1000 Ohm resistor and a 180 pf capacitor for a corner frequency of about 900 Khz. The free end of the resistor is connected to the VFO source (the top of RFC2) and the free end of the capacitor is grounded. Then the junction of the resistor and capacitor is connected to C7, but the value of C7 should be augmented to 10 or 15 pF to compensate for the loss of VFO signal in the filter. The other side of C7 remains connected to pin 6 of U1, NE602.

Wayne Burdick cautioned me to maintain at least 600mV P-P of VFO drive at pin 6, otherwise we will lose signal at the fundamental.

This change helped enormously. The phantom SW broadcast signals are almost entirely gone and the receiver works normally for legitimate signals. You may or may not be interested in making some change of the sort described above; most people do not operate in the range 7.075 to 7.095 so you could choose to ignore the images. It also probably depends on the antenna you use. Mine is a high dipole.

But I like my NorCal 40 better with the phantom stations eliminated. Many thanks to Wayne Burdick for his advice and kindness.

73, Ed

On Unwanted Receive Images

by Wayne Burdick, N6KR
1432 6th Ave.
Belmont, CA 94002

Some NorCal 40 users (including me) have found that there is occasional leakthrough of strong shortwave broadcast stations in places on the NC40 dial that they shouldn't be. This is a common affliction in simple superhet receivers using down-conversion to low I.F.'s (intermediate frequencies), and is not limited to the NC40.

For example, Ed Burke (KI7KW) was hearing signals in the 7.060 to 7.090MHz range that he figured were actually images leaking through from signals in the 2.7MHz range. How did he come up with that? Simple: The NC40 front end is tuned to the *sum* of the VFO and the I.F., or 4.915 + 2.085 = 7.000. Ed noted that the *difference* between the VFO and I.F. is 4.915 -2.085 or about 2.83MHz. Even if the receiver circuits are properly tuned, extremely strong signals in this range might be received on the NC40. (In fact, you could exploit this "feature" and make a band-imaging radio—one that tunes two ranges with one VFO.)

Anyway, I have a different theory for what Ed is hearing. Here's the note I sent him

(via e-mail):
* * *

Ed, thanks for the question. I don't think the images you're hearing are at [I.F. - BFO]. What may be more likely is that you're hearing images that result from harmonics of the VFO. For example, if the rig is tuned to 7.046MHz, that puts the VFO at 7.046 - 4.915 = 2.131MHz. The 7th harmonic of the VFO is 14.917MHz. Even though the 7th harmonic is weak, a strong WWV signal at 10MHz can leak through, because 14.917 - 10.002 = 4.915! (Try it: repeak the NC40 front end at 10MHz and you'll hear shortwave broadcast stations. The lowpass filter may provide 20dB of rolloff at 10MHz, but that isn't very effective given the power of these monster broadcast stations.)

The lower-order harmonics can cause trouble, too. The 3rd harmonic is around 6MHz, which when added to the first harmonic again results in an RF image in the 10 to 11MHz range, which the input filter only does a fair job at removing.

There is no complete cure for this, because the '602 and all other mixers produce sum and difference products of their inputs. However, you can cure some of the problem by using a low-pass filter between the VFO and the receiver mixer '602. This will reduce some of the harmonic content of the VFO.

To add some filtering, try putting a 10 to 30 pF capacitor between pin 6 and ground at the '602 while listening to the leakage from an AM station. Try several stations if possible to see if any of them are eliminated with the cap.

A 2K-ohm resistor in series with the VFO can make the LPF more effective. In fact, I did something like this in the Sierra circuit. In this case, the 5pF series capacitor should be made larger to compensate for the loss due to the resistor. Measure the voltage at pin 6 using an RF probe to make sure you're not reducing it below about 200mV RMS. If you do, you'll start losing signal at the fundamental, too. 72, Wayne

The Origination of the "Internet Fox Hunt"

by Chuck Adams, K5FO
9814 Limerick Drive
Dallas, TX 75218

At the start of the winter season is an exciting time of the year for me. Forty meters begins to quieten down from the summer thunder boomers that we have in Texas and other places around the northern hemisphere. These storms, both day and night, tend to make the band very noisy and very difficult to use for weak signals typically found at QRP and QRPp levels. The winter months are typically cold and damp, thus inside activities pick up and operating on 40M becomes a higher priority for me and has been for 35+ years.

In looking at the calendar of ham events for the year we find that during summer months weekends are taken up by yard work and other outdoor activities, thus ham radio takes a back seat to the list of priorities, especially for the average home owner. There are hamfests in nearby burgs, or even some trips are planned for the larger meets in the area to catch up on the latest and greatest gadgets that one has just gotta have. But operating and getting on the air just doesn't get the attention it needs.

It seems also that there is some QRO type contest activity going on every weekend for some group. There are of course the really big contests like Field Day, SS (Sweepstakes), CQWW DX Test, and on and on goes the list. QRPers do and should take part in these for two reasons. One: you can get the rare DX or state that you need for some awards. Two: you can fair farely well against the higher powered stations even with less than 5W and it shows the "big guns"

that "little pistols" can be heard. I've found that the good operators are very good at working the "weak ones". Casual operators may tend to neglect and/or not want to work someone that isn't just banging the speaker or headphones at a loud volume.

I got to thinking, and that can mean serious trouble, that there just wasn't any activity during the week and mostly during the evening when I get home from work. Yes, I do get on when I can and work a few stations and in general enjoy the thrill of working "new ones" with the low powered homebrew rig(s). So I thought, why not come up with something for the internet group.

Typically, a "Fox Hunt" usually consists of a VHF station being taken and hidden somewhere and then other radio amateurs with all kinds of exotic and standard equipment go out in the territory and try to find it. This is done with certain goals in mind: 1. least amount of miles put on the odometer, 2. least amount of time from start to finding the hidden station, and other quantitative measures. We couldn't do this with a group of individuals spread around the world. So, why not have a station come on the air for two hours, preannounced, and work everyone that they can from the internet? Why not indeed? So that's what I thought of and implemented. This station becomes what I call the "Fox", the one being hunted by other stations across the world.

The idea is to get a group of stations that would volunteer to get on the air during a day in the middle of the week they pick and for two hours. I came up with 11 volunteers, using each twice over the period of the winter, thus 22 weeks of activity for two hours per week; one station volunteering for that week. The goal was for each person to work as many as possible during their two hour period and then publish their results to the internet group. Thus each "Fox" would get two chances to run up their grand total count of number of stations worked. They could work the same station during each of the two sessions, but not count individuals but one time per session. At the end of this fox hunt, the "Fox" with the most stations contacted in four hours would be the winner.

On the opposite side, the other stations, included would be foxes in past and future weeks could work the current "Fox". This would generate a pileup of stations wanting to work the QRP station. It started off well and now into late December and early January the activity has really gained momentum.

It does several things at once. It gets people to operate more and do it on 40M during the winter time and during the middle of the week when bands aren't as crowded as weekends and as competetive. It gets the internet group to communicate with each other using rigs that they have talked about over the keyboard. We get to hear real live signals direct from the person, not relayed by some hard cold network of digital computers, phone lines, modems, and other "high tech" systems on the Internet. I'm hoping that code speeds will go up for the Tech+ and Novices as the "Foxes" have set aside time in the Novice segment of 40 Meters.

As an added incentive I put up two prizes, two NEx0-40 kits from NN1G, one each for the Fox and the "chasers" with the highest totals. These will be the "trophies" for the informal contest.

I see the activity generated by this and hope that it is for the good of the QRP community as a whole. I see enthusiasm generated by the new people that here is something that is somewhat competitive. Some of the new people as foxes are learning new skills on operating with some pressure on them to hear everyone, just like in some contests or being rare DX. Hopefully everyone will benefit.

The enthusiasm has spilled over into posting of results and others posting what they heard and who else they worked. Steve, AB4EL, has even posted a "list" of the people that might be on the air during this two hour period so that if you were on frequency or near the posted frequency of the fox, you would know who to call and get a contact with a

fellow qrp-l member. This has upped the traffic on the qrp-l list the following day. This tends to irritate the more serious minded individuals and those that feel it is inappropriate for the group. My personal opinion is that I like to get all the information that I can about any subject that I'm interested in. I do not specialize in just one area. I want to know just like many other inquiring minds. To me, the posting of personal information about what a person felt and how they enjoyed an activity is more meaningful and just as much a part of the hobby as the detailed design and description of a complete transceiver or antenna system. That's what makes the system work.

With as many individuals as we have in the qrp-l group, if a large portion of the group contributes (which is not the case) then there will be a tremendous explosion on the list and that is just the way of the system. It is an unregulated system and the signal to noise ratio (whatever that is) is pretty good as compared to other sources of information on the internet. Those who have to pay for their internet services have either got to come up with a cheaper way or find an alternative source. There is just no other way. It's a fact of life that education is expensive, anyway you get it (CNA). Look for flat rates on email services if your cost is too high. I personally can't seem to get by without my "fix" of daily postings of the group.

So, the contest is more than half way through and several "big" QRPers are leading the pack. I'll follow up in QRPp with the final tally. Hopefully we can make this into an annual event with again two prizes for the winners.

I'm working on a building contest for Dayton. I've gotten some leads on one or two clubs that want to do the kitting for a small one transistor xtal controlled transmitter to be built at Dayton for another prize(s). Stay tuned for an announcement over the Internet and in QRPp before the big day. Bring your soldering iron to Dayton.
dit dit Chuck Adams K5FO CP-60 adams@sgi.com

Fox Hunt Adventures from the Internet

by various authors

The following are excerpts from the Internet Fox Hunting group. This should give you an idea of what the Fox Hunt is and how much fun these guys are having doing it. Hope you enjoy it. Doug, KI6DS

Fox Hunt Nov.4 (UTC), 1994

The fox hunt last night was hindered by QRO RTTY, and Packet. I guess that has become the norm though so why complain.

We also had our share of QSB and QRN. Receive sensitivity seemed to be down or noise floor up last night, even more than usual for the -3dB pad field antenna. Can't tell for sure though because of the new QTH. Craig reports that Nov.3 propagation was predicted to be poor. Just my luck!

Thanks to all of the hardy ops. who fought their way through. Nearly all stations logged were worked in the novice segment.

(UTC)	Call	RST (Rcvd)	RST(Sent)	SPC
00:00	NN9K	559	579	IL
00:05	NM1JK	559	559	?
07:10	N3PFF	?	559	PA
07:15	K5UP	559	559	OK
07:20	AB4OU	449	339	NM
07:25	N9OUH	?	579	WI
08:20	KC5EQC	599	339	OK

72,73 Clay, N4AOX QTH nr Knoxville, Tn. wyn@ornl.gov

Date: Fri, 28 Oct 94 16:00:28 PDT
From: "Stan Goldstein, N6ULU" <stan@cruzio.com>

Finally had my turn as the fox. Felt like a real contest with all the qrm. Thought about turning on the BIGRIG & AMP to get a clean freq as a lot of guys were severely encroaching on the freq, but I didn't and made my stand qrp. Worked 14 guys for sure and 1 maybe. The maybe and I exchanged sig reports, but when I asked him if he was in the fox hunt, he didn't come back to me.

The 14 in the log are :

1	W1HUE	Larry	8	KF8EE	Ted ?
2	N4UOX	Clay	9	K8BVJ	Jack
3	W3PM	Gene	10	WB2SXN	Bing
4	AB5OU	Tim	11	N1IRZ	Dave
5	AC4QX	Red	12	AB4EL	Steve
6	W5TFB	Jack	13	W2RXG	Bob
7	K5UP	Glen	14	WA3NNA	Pete

The maybe was KB7SO. Thanks to all you guys for working me. I enjoyed doing this a lot, Thanks Chuck for setting this up. 72 Stan, N6ULU

From: prvalko <prvalko@vela.acs.oakland.edu>
Subject: Thanksgiving Fox Hunt Results

Hot off the press! This mornings' results...

	CALL	GMT	Sent/Rec	Details
7.110	N1NTQ	12:27	579/479	Steve, New Britain CT
	VE3CHK	12:40	59/579	Ed, Ottawa (He was on SSB!)
	KB2SEM	12:50	569/579	Dan, Bricktown NY
7.040	K0HUU	13:07	599/569	Don, Springfield MO
	WA3PTY	13:20	339/539	? qrm/qsb
	NG9Q	13:32	589/579	Chuck, Collinsville IL
	WB2PPQ	13:45	449/449	Greg, Chattam NY
	WA3GYW	13:58	339/449	? lost in the rising QRM

Eight QSO's in two hours... not too shabby. Running the Argonaut 515 to my 45' high full wave. Abt 3 watts to the antenna. GOSH that was fun! Now off the my in-laws for the holiday! 73 =Paul= WB8ZJL

Date: Thu, 15 Dec 94 08:04:07 EST
From: "Robert E. Easton" <bobea@watson.ibm.com>

UTC	CALL	HisRST	Name	QTH
0209	WB4ZKA	549	Mike	Phoenix, AZ
0221	K5UP	559	Glen	Bartlesville, OK
0233	KK6MC	339	Jim	Lawndale, CA
0245	NN9K	359	Pete	Colona, IL
0251	N6ULU	239	Stan	Watsonville, CA
0334	N4AOX	349	Clay	Alcoa, TN

It was a FINE evening for long skip. The closer stuff was disappointingly weak. NN9K and I had a brief QSO Sunday evening that was an easy S8, but last night he was down in the mud. N4AOX is usually much stronger too. Then there's a whole lot of 8, 9, 4, and 3 land folks that I couldn't hear at all. It would have been nice to have more QSOs, but we take the propogation we're handed.

Chuck, on your theory of reciprocity: Those signals that were just above the noise floor gave me the same RST I gave them. With the OHR Spirit, it looks like I can work anything it can hear, even if I have to crank both RF and AF gain wide open.

On the happy side, AZ and CA were new states for me on 40M QRP. THANKS guys! ... and THANKS especially to those who have to modify their homebrew rigs to work the novice section! 73, Bob - N2IPY

Date: Wed, 21 Dec 1994 21:14:13 -0800
From: ka7uld@ix.netcom.com (Mark Cronenwett)
Subject: Fox Hunters Bagged at KA7ULD

Well Gang, It was unusually bad for me last night. The noise was running S5 to S9 at 7.120, and usually an S5 on 7.040. I also found I could not use my narrow filter, it just made it impossible to hear anything. I have had much better days, but have not ever worked that far on 40 from this location. It did show me that I can be heard a lot farther than I can hear. Pulling Steve (AB4EL) out of the mist was really tough, but he just happened to hit it right. I could tell that there was a pileup out there, but it was hard to tell through the noise. I know I missed a lot of people, so for next time I am going to try some of Steve's little hints. The reason I moved down to 7.117 was that a BC station opened up here all of a sudden, and I heard nothing. Next time I will just stick my foot in my ear. I am also very bad at contesting, so ymmv.

UTC	Call	Name	QTH	Sent	Recvd.
0410	WB4OWL	Charles	CA	449	599
0425	AB5OU	Tim	NM	229	559
0429	NA5K	Henry	TX	349	559
0433	KC5EQC	Don	OK	229	449
0439	AB5WB	Andy		349	459
0444	KO6CL	Rich	CA	559	559
0521	AA7AR	Bruce	CA	459	599
0538	AB4EL	Steve		219	559
0545	NA5K	Henry	TX	119	439 *Second Time—Worse!!
0558	K5UP	Glen	OK	129	339

Gear Used: (if anyone cares)

TS-430S at 5 watts into an HF6V on the roof of my house (can I include the power lines in this as a handicap?). If anyone wants to come over to my house and see the setup, and provide helpful suggestions, you are very welcome, especially if it will improve the situation. Best send email responses to mcron@dogbone.csd.sgi.com. Any responses to my good footwork can also go to that address instead of the list. 72, Mark Cronenwett, KA7ULD

Date: Thu, 29 Dec 1994 19:10:48 -0800 (PST)
Subject: FOX recap

Thanks to all the faithfull who stayed with it and let me hear them through the bad noise up in Idaho. Wx was light rain and the noise was from S3 to S8, back and forth! Here is what I wound up with.

Time	Station	Sent	Rcvd
0300	AB5OU	559 ID	569 NM
01	NA5K	579 ID	579 TX
05	N6ULU	599 ID	599 CA
06	K5UP	449 ID	579 OK
14	WW7Y	579 ID	Lost him in the noise
16	AB4EL	559 ID	Lost him in the noise
20	KC5EQC559 ID	529 MO	
21	K6QQ	579 ID	429 CA
26	KB0LMQ	569 ID	358 CO
33	AB4EL	549 ID	589 NC
42	N0ZYK	599 ID	599 CO
0404	VE6GK	559 ID	599 AB
13	AB4EL	339 ID	589 NC
16	KE4PC	339 ID	449 TX
26	WA6HHQ	589 ID	589 CA
40	KK6ZC	549 ID	589 CA
41	WB0GIX	589 ID	589 CA
43	N7AFB	599 ID	599 MT
57	NN9K	339 ID	449 IL (This one was very hard to get. Noise and signal up and down togeather!)

I was using the station of Idaho's Section Manager, Don, KA7T. I used to live one place west of him. Super guy. Works lots of 160.

Rig........TS950 down to 5w out.

Antenna....2 ele yagi up about 80 feet.

N0ZYK sounded like a new ham. About 7wpm and sending a few letters wrong now and then. Have you ever tried to explain a contest format at that speed? But the newcommers are the life blood of amateur radio. We must always remember that we were all new once. If it takes 15-20 mins, don't sweat it. Work that much longer if you want. I think Chuck and all the rest would agree. Lets be sure EVERYONE has fun. Again, thanks to all, Ron KU7Y.

NorCal 40 to NorCal 40A Conversion

Wayne Burdick, N6KR
1432 6th Ave.
Belmont, CA 94002

This article details the steps required to convert a NorCal 40 to a NorCal 40A. Even if you don't have an NC40, this should make interesting reading because it illustrates what we learned from experience with the original design.

You can make as few or as many of the modifications as you'd like, but I recommend starting with number 1 and working your way down the list.

Refer to the NorCal 40A schematic elsewhere in this issue of QRPp. Modifications marked with an asterisk (*) below will look familiar to some because they're similar (or identical) to the equivalent circuitry or hardware in the Sierra.

*1. Variable transmit monitor pitch. This change is made to the crystal oscillator part of the transmit mixer, U4 (sheet 2). C34 becomes a 50-pF trimmer, C35 is increased to 270 pF, and L5 is increased to 18uH. The 18uH inductor increases the pitch range a bit. Once this is done, you'll be able to adjust the transmit monitor pitch to your liking, and the

transmit spurious content will decrease (the original caps make the oscillator output too high). Remember that no matter where you set the TX monitor pitch, that also becomes the received-signal pitch you need to listen to guarantee that you call other stations on frequency.

*2. Variable receive I.F. pitch. Find U2 on sheet 1. Change C17 to a 50pF trimmer and C18 to 270pF. Once you make this change, you can set the center pitch of the I.F. passband. Anytime you change this adjustment you may also need to reset the TX monitor pitch, which will be affected.

*3. Transmit falling edge shaping. The original NC40 has a very hard falling edge on the keyed wave form. (The rising edge is nice and smooth because of the startup delay caused by L5 in the transmit mixer). To soften up the falling edge: (1) Add D10 and C56 to the driver circuit; there is no need to change the value of R13. This gives the driver output an exponential decay. (2) Change R9 to 47K and add C57. This keeps the transmit mixer alive for an extra 10 milliseconds or so to give C56 time to do its thing. Looks at it on an oscilloscope in the before and after cases if you get a chance.

4. Receiver gain improvements, Part 1. The NC40A has enough RF and audio gain (at last!) to drive a speaker, thanks to a number of tweaks to the receive chain that increase overall gain by around 8 dB. Here are the first couple of changes, which are very simple to make: (1) Increase the gain of the LM386 by 3 to 5 dB and reduce its hiss level at the same time by adding C55 and R22 between pins 5 and 8. (2) You'll buy another 1 dB of receiver sensitivity by replacing Q1 with a 2N4124. This is because the 2N2222A has higher C-E capacitance, which affects the Q of series-tuned circuit C1/L1. (The junction of C1/L1 is a very high impedance point. This is why Q1 is effective at muting the RF on transmit—it kills the Q of the circuit and effectively puts C1 at ground potential.)

5. Receiver gain improvements, Part Deux. You'll have to get serious to do the rest of the receiver sensitivity improvements. Study the NC40A schematic, then add T2 and T3/C6, and change L4/C14. Once you've made all the changes, you may want to rewire AF gain pot R8 as shown; this will make it function better as an AF gain control than in the old circuit. Also see "AGC," below.

6. 10K VFO pot. Doug Hendricks pointed out to me that it's far easier to find a ten-turn 10K pot than a ten-turn 100K pot. If this has happened to you, never fear: you can scale a few resistors in the circuit by a factor of 10, then drop-in a 10K pot for VFO tuning. Change R20 to 4.7K and R15 to 510 ohms. DON'T change R19, which is there for isolation and has no effect on the voltage supplied to D8. Next, you'll a 1K pot from Mouser to replace R16, the RIT pot; you can use the same 1K pot specified in the parts list for the RF gain control. Finally, add your 10-turn, 10K pot at R17. (Note that the NC40A PCB has been rearranged to make room for a 10-turn pot without drilling a different hole in the front panel.) If you study the RIT circuit you'll find that it is simpler, now, but there's no point in modifying the NC40 since there's no change in performance.

*7. Threaded-bushing toggle switches. The front and back panels of the NC40A are more rigidly attached to the PC board thanks to the use of toggle switches with threaded bushings, S1 and S2. This switch is not a standard part, but we ordered them in large quantities for both the Sierra and NC40A, and may have some left over for those who're interested.

8. AGC. The most difficult problem in designing an AF-derived AGC circuit is achieving a fast attack time. The original NC40 AGC circuit is quite good in that respect, because of the tight coupling between the AF output and the JFET AGC elements. There is almost zero delay in this loop.

What the NC40 AGC lacks is wide dynamic range. I spent a month of "spare time" experimenting with ways to improve it, including: (1) replacing the MPF102s with Siliconix

VCR4Ns, which are optimized as voltage-controlled-resistors but are quite expensive; (2) replacing the JFETs with photoresistor/LED control elements, which have a wide dynamic range but slow response time; (3) replacing the JFETs with a gain control IC, such as the MC3340, which has good dynamic range but adds noise and current drain; and (4) various NE602 gain-reduction schemes better left for a bad Sci-Fi movie. (This movie would definitely co-star Eric Swartz, WA6HHQ, who provided me with moral and technical support throughout the Search for the Perfect Loop Constant.)

I finally settled on an enhancement to the JFET circuit that centers around resistor network R5 (see schematic). When you use a JFET as a voltage-controlled resistor, it stays linear as long as the signal at the source is down in the 150 mV peak-to-peak range. But with the addition of feedback from source to gate, you can linearize the response up to around a volt p-p at the source, for a 10 to 15dB improvement. The linearization resistors also improve signal symmetry.

Because I'm using a differential circuit, I needed two voltage dividers to provide the feedback. In the NC40A, R5 is a SIP (single-in-line package) resistor network that contains four 1M resistors, but you can use four 1M, 1/8th watt resistors. D1 and D3 keep the gates isolated from the QSK delay cap, C28, and from each other. D5 and D6 form a full-wave detector, biased at pinch-off by properly setting R6, the AGC threshold control. (This eliminates the "R6" problem—hand-picking one resistor—that we had with the original circuit.)

C29 sets the AGC time-constant, and is connected to +8V rather than ground to eliminate the turn-on charge-up problem. C25 keeps the wiper of R6 at a low impedance at AF. Finally, R3 and D4 are used to keep the voltage on C29 from being pulled down during transmit.

This circuit is more complicated than the original, but it improves performance without increasing current drain, which is still essentially zero. "Hmmm," I can hear you thinking, "Should I bother?" Only if you're not satisfied with the original, and you're willing to re-wire the entire AGC circuit.

*9 Plastic latches. The plastic latches on the Sierra were an instant hit. While the intent was to provide easy access to the interior for band module swaps, it turns out that everyone likes the latches because they can show off the Sierra at meetings. Not one to buck popular demand, I added the latches to the NC40A, and you can add them to your NC40, too. You'll need four 5/16" 4-40 screws with lock washers and nuts, and a pair of Southco 07-10-102-12 latches. Drill two .125" diameter holes for each latch, with the holes spaced 0.25" from the edges where the top and bottom covers meet.

HAM RADIO: HAZARDOUS TO YOUR HEALTH?

RAC CONVENTION 1994

Rick Zabrodski M.D.

(This manucsipt was the basis for a talk given at the convention)

Introduction:

Over the past 10 years the general public has become increasingly concerned about electromagnetic fields (EMF) and their possible effects on the human body. Numerous articles in the press have linked electric power lines and other electrical equipment such as cellular phones to cancer in particular.

After reviewing the available data, I conclude that, if EMF poses a health hazard for the ham radio hobbyist, the risk is relatively small. The effect on the typical ham radio opera-

tor is not likely to be a major problem. This is apparent when comparing EMF to the many well known, documented hazards that we face on a daily basis. However, EMF exposure does raise concerns; and further study together with "prudent avoidance," is advised. I will present a brief summary of what is currently known on this complex and rapidly expanding area of research. Then I will conclude with a rationale for appropriate, prudent behavior based on this knowledge.

Definitions:

To better understand the issues involved in EMF, we must first determine what aspects are relevant to the hobby of ham radio. EMF is usually divided into two categories, Ionizing and Non-Ionizing. Ionizing radiation involve frequencies from the ultraviolet spectrum and up. Examples include solar radiation, x-rays and radiation from nuclear explosions. The serious side-effects of ionizing radiation are well known and depend on frequency, intensity, and duration of exposure. This knowledge has led to specific public and occupational exposure standards (e.g. for x-ray technicians and employees of nuclear plants). Fortunately, your transmitter does not emit any ionizing radiation! The second category of EMF, more relevant to amateur radio, involves frequencies in the non-ionizing spectrum. This spectrum stretches from very low frequencies to the infrared region. Examples include EMF from power lines, transformers, and electric motors and radio frequencies stretching from VLF through microwaves. Non-ionizing EMF is further subdivided into thermal or athermal. That is, does the radiation heat tissue? The answer depends on wave-length and intensity. For example, we know that we can use relatively low-power microwaves to cook food and low-power infrared lasers to burn tissue in surgery. However, an individual situated near a high- power (megawatt) mf/hf/vhf antenna would experience biological heating (thermal effects). The ANSI (American National Standards Institute) guidelines have suggested limits for public and occupational exposure and these limits have been lowered repeatedly over the years and they remain a topic of debate.

Application to Ham Radio:

In amateur radio we are usually concerned with lower-level radio frequencies that do not cause measurable heating to the body and are therefore classified as athermal. Currently there are no published scientific safety standards for power levels and frequencies that do not cause thermal effects. This is where most of the controversy begins! There is still not enough scientific evidence to establish what is going on here. Despite this we hear emotional statements from concerned citizens' groups and the equally polarized public-relations statements of profit-oriented multinational corporations. The potential consequences for various groups, including amateur radio, are tremendous. If a cause-and-effect case for a health hazard can be made, the cost implications will be enormous. If you think antenna restrictions are a problem, consider the problems of having to prove that you have an EMF compliant radio station! A wide variety of scientific investigations from numerous sources have shown clear measurable biological effects secondary to athermal EMF. In describing these effects, the following hierarchy of biological levels is useful:

* Free radicals
* Cellular
* Tissue
* Organ system
* Whole organism
* Populations

To complicate things even more, research at the level of cells and tissues suggests that other factors besides frequency and intensity are important. EMF modulation, band-

width and timing characteristics have all been shown to have different effects. It is apparent that certain EMF "windows" may be more important than others. What are some of these effects? At the cellular level EMF causes measurable changes with calcium and hydrogen ions. There appear to be changes in cellular communications by way of electrochemical and enzyme pathways. These effects have been studied particularly in immune cell function (T-cells), as well as in cell growth and other types of cell recognition systems. At the level of tissues and organs we now have evidence that the brain hormone melatonin is also affected. All the above are certainly interesting to biologists, but how do they affect you and me?

The current literature suggests that EMF probably does not cause cancer. However, it may have a role as a promoter (enhancer) of cancer by modifying the cells in the immune system that normally act to prevent or correct cancer in its early stages. In other words, cancer cells may be created by a chemical agent or ionizing radiation. Subsequently the EMF-handicapped immune system may not be as effective in identifying and destroying these cells in time to prevent further cancer cell growth.

At the other end of the hierarchy are the groups of organisms that we call populations. The study of diseases in populations is called Epidemiology. The often quoted epidemiological study, published in 1988, took as its "population" those amateurs on the 1984 FCC license file who had addresses in California or Washington State. After eliminating female names, the investigator matched 67,829 names against death records in the two states. From analyzing a substantial number of causes of death , he found that deaths from one form of leukemia and from cancer of other lymphatic tissue were higher than expected, by a statistically significant amount. Cancer of the pancreas accounted for significantly fewer deaths that expected. Is misleading, however, to place such emphasis on a few significant results that emerge from an extensive search. None of these were highly significant, and it would be reasonable to attribute them to chance. Importantly, about one-third of the amateur radio operators who died in Washington State had occupational electromagnetic exposure together with potentially significant exposure to solder fumes and toxic chemicals including PCBs. This study and many others like it did have not measured actual cumulative EMF exposure. They only reason that such exposures were likely to occur. What about the effects of EMF on female hams who live in Iowa? Often epidemiological studies give rise to more questions, rather than answers! Some subsequent epiemilogical studies involving occupational exposures (generally much higher than hobby exposures) to EMF tend to support the atypical cancer findings initially described. These individuals were usually exposed to numerous other agents, and it appears that chemical exposure was particularly important. The "silent key" study provides no conclusive proof of a cause and effect relationship between EMF and cancer.

Therefore, we now know that non-ionizing, athermal, low-level radiowaves used in amateur radio do cause biological changes in the human body that are measurable at the level of cells, tissues, and organ systems. The significance, if any, of these changes remains uncertain. It currently appears unlikely that they can be directly linked to causing cancer. Unfortunately, the possibility remains that they have a small but not yet clearly defined role in allowing other more toxic agents to cause cancer by promoting or enhancing their effects. Other effects may exist, both good and bad, that are yet to be described. I believe that, ultimately, this area of biological rather than epidemiological research will yield the definitive answers to our questions. At the same time we may also develop a better understanding of cancer and immunological diseases such as arthritis and AIDS.

When we look at the scientific evidence at the level of the organisms and populations, the possible links between EMF and disease continue to be poorly understood. Nonetheless, the evidence raises concern, particularly in those individuals with signifi-

cant exposure to EMF and other potential cancer-causing agents in their occupations. More study in this area is also indicated!

Relative Risks and Prudent Avoidance

Considering all this information, it would be wise to practice "prudent avoidance." As a ham-radio-physician, I offer this advice:

* Don't smoke.
* Don't get fat.
* Eat sensibly.
* Exercise regularly.
* Wear a seatbelt.
* Wear a sunscreen in the sun.
* Wear a bicycle helmet when riding your bicycle.
* Climb your tower on sunny, windless days and use a proper climbing belt.

Paying attention to the these issues will provide a clear, measurable, and significant benefit for your long-term health. Once you have consider this advice, what about ham radio and EMF?

First, we must recognize that the ANSI guidelines apply THERMAL effects. Furthermore, they do not take into account the modulation-dependent interactions that seem to be important in athermal EMF research. In fact, there are no guidelines for ham-radi o-type exposure to EMF at present. However, I certainly would agree with the following general principles:

* QRP : Use the lowest possible power as conditions permit. This is particularly important at higher frequencies and in situations where the antenna is close to the operator. The use of UHF/VHF handhelds would ideally involve a separate microphone with the radio and antenna held above your head. If this is not possible, the handheld should be kept as vertical as possible using low power and brief transmissions. (Leave the long winded-lectures to 75 metre AM.)
* When operating HF at levels of 100 watts or less, beams should be kept at least 35 feet above the ground, and higher when using more power. On a typical suburban lot a vertical should be roof mounted. (They usually work better up there in the clear anyway). Any indoor antennas should be restricted to QRP use only.
* Finally, your linear should be reserved for "true emergencies," such as working 3Y0PI on the last day of the Dxpedition as a "new one" for the DXCC honor role.
* I would emphasize that special care is required when operating at microwave frequencies as the chance of significant athermal and thermal exposure is much higher. Further, more detailed suggestions can be found in various sources, including the ARRL Handbook and the ARRL Antenna Book.

In summary, we now know that non-ionizing, low-level, athermal EMF does cause measurable biological effects. The consequences of these findings are yet to be accurately assessed, but further information will be forthcoming. Those at highest potential risk are individuals who have prolonged occupational exposure to EMF and have additional exposure to other potentially toxic agents. Although further study is needed, it appears that the risk from exposure to EMF in ham radio remains low when compared to other established health risks. "Prudent avoidance" is recommended. I hope this encourages all of you to quit smoking, eat smart and exercise safely. These measures, together with prudent QRP operation and high antennas, should allow us all to discuss this topic again for many years to come!

About the author:

Dr. Rick Zabrodski has been a licensed ham since 1971. He is in private practice as

a family physician and occupational health advisor to various corporate and government clients. He has dabbled in almost every aspect of ham radio over the years but his current interests are qrp contesting, building qrp equipment and occasionally chasing dx. He has a special interest in aviation medicine and is a pilot with a preference for "silent flight" over the Canadian Rockies. VE6GK (Glider King) lives in Calgary, Alberta, Canada with his wife Rhonda and two children, Adam and Sarah who plan to become hams in the near future. He can be reached at: zabrodsk@med.ucalgary.ca

Acknowledgments:

The author wishes to thank Stuart Cowan, W2LX and Dr. Ross Adey, K6UI both who were very helpful in providing me with access to the current literature and made the research much easier. Thanks to all the scietific hams and non hams who provided input via the internet. And a special thanks to Dave Hoaglin, K8JLF who helped with the preparation of this manuscript.

FULL POWERED SIERRA ON 160, 12, AND 10 METERS

by Dave Meacham, W6EMD
206 Frances Lane
Redwood City, CA 94062-2733

Originally, my Sierra, with an MRF-237 PA, produced 0.9 - 1.0W on 10 meters and 1.9W on 30 meters. On 160 power fell off rapidly from 2.4W at 1810kHz to about 0.5W at 1840. By changing the windings on T2 and adding one capacitor the Sierra output power can be raised to 3 Watts on 160 and to about 2 Watts on 12 and 10. The power still falls off on 160 but now there is about 1W at 1845kHz. Simply rewind the transformer as follows, using the same layout and polarity as as the original:

Primary - 18 Turns of No. 26 evenly spaced to cover most of the core so that the lead positions fit the same board holes as the original design.

Secondary - 5 Turns of No. 26 with the same spacing as the primary (turns placed in between primary turns). Fit leads to the same board holes as original.

Capacitor - Add a 56pF silver-mica capacitor on the bottom of the board with very short leads to the secondary pads of the transformer (capacitor in parallel with the output of T2).

That's all there is to it. Now your Sierra output power should be roughly 2 Watts (or more) on all nine bands. ENJOY! 72, Dave, W6EMD

Another R2/T2 Station

Ralph Irons, AA6UL
6300 Friant Dr.
Bakersfield, CA 93309

Building KK7B's R2 and T2 and all the associated circuits (vfo, rf splitter, quadrature phase splitters, linear amplifier, preselector, and low-pass filter), and getting everything to function as a station on one or more bands, is a very enjoyable, but a rather long-term and open-ended undertaking. This is a project for someone who likes to tinker, who is not looking for a polished finished product in a few evenings, and who is willing to encounter and solve problems. Once he has the satisfaction of getting the station working on one band, the builder will want to try new bands, new modes, better TR-switching arrangements, a receiver preamplifier, various quadrature phase splitter designs, VFO designs, etc.

Here at AA6UL, the R2 and T2 kits from Kanga US were used in building a 40 m cw/ssb station. An excellent December, 1994, *QRPp* article by K7RO gives the basic diagram

of such a station, along with a lot of other very useful information.

The W1FB Universal Vfo for 40 m was built using ugly construction over a groundplane. This vfo is pretty stable after an initial half-hour warmup period. K7RO suggests using a lower frequency vfo with a doubler circuit, to minimize FMing and audio problems caused by RF feedback to the vfo. The vfo output is split to feed both quadrature phase splitters, eliminating the need for switching the vfo between R2 and T2.

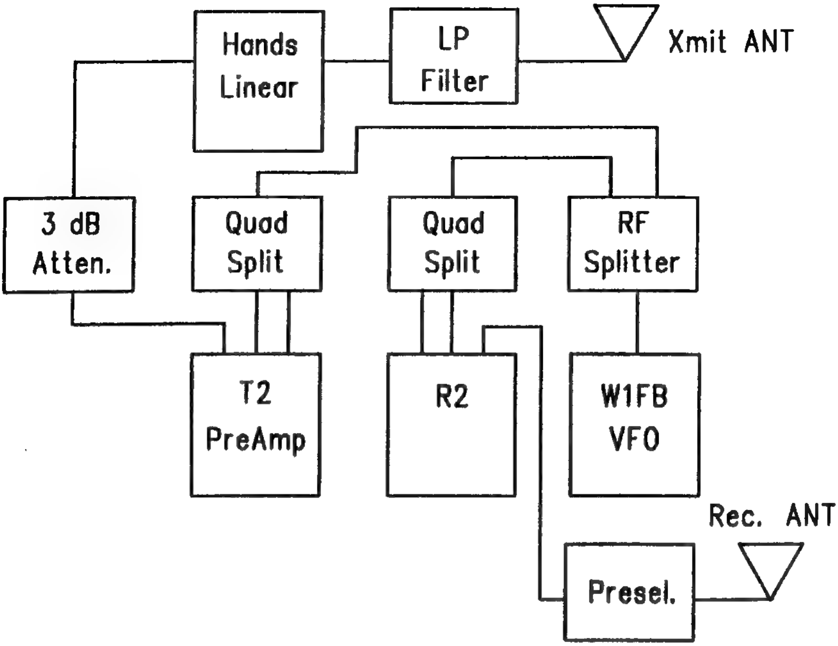
The Hands Electronics broadband linear amplifier kit (also from Kanga US) was selected to boost the 1-3 milliwatt output of T2. Though 3 milliwatts is supposed to drive the Hands linear, the T2 exciter constructed at AA6UL would not drive it. The first three stages of a four stage broadband rf preamplifier strip (p.135 in the second edition of the *W1FB QRP Notebook*) was used to obtain sufficient drive. The Hands Electronics 20 w amp puts out 10 w with this level of drive. A simple resistive pi-network 3-db attenuator was used to reduce the drive, giving 5 w output. KK7B does not recommend using T2 at higher power levels (see his April 1993 *QST* article).

The W1FB vfo by itself drives the Hands amp to 40 w. Again, simple resistive attenuators may be used to reduce the drive level. R2 and T2 aside, this linear should be very useful to those wishing to operate multiple hf bands. For cw, all that is needed in addition to the Hands amp is an oscillator and a low-pass filter, together with attenuators for desired output levels.

At AA6UL, only the most primitive tools are available. R2 and T2 were built into separate soft-panelled, easily drilled Radio Shack chassis, with lots of filing to enlarge mounting holes, and generous sanding around them to ensure good ground connections. The temptation to construct a teeny rig was successfully resisted. Everything goes in its own box. The resulting station is much larger and cable-ridden than the cute little one-box rigs, but experimentation is encouraged by a modular approach. Want usb instead of lsb? Detach and flip over the quadrature phase splitter boxes. Want to operate satellites? Set aside the vfo splitter box, and connect separate receive and transmit vfo boxes. (Separate transmit and receive antennas are used at AA6UL, in anticipation of mode K operation.) Other bands? Plug in new vfo, phase splitter, and low-pass filter boxes. How about a DDS vfo — or a digital quadrature phase splitter? Projects like these are much easier to try with modular, removable circuit elements. Also, once built, these modules may be easily used in other projects.

Few difficulties were encountered in building R2 and T2. The R2 parts placement diagram supplied by N8ET (Kanga US) had many of the components in the two audio channels reversed. Due to the great symmetry in the design, it turns out that these reversals make absolutely no difference. They were good for a few tense moments, though. Secondly, and more importantly, the T2 board contained a defect — with one LO channel input trace mistakenly grounded. The T2 parts placement problems noted by K7RO in his *QRPp* article had been corrected. The boards are sturdy, plated-through glass epoxy. A fine tip iron is a must (no fewer than five solder bridges were discovered at AA6UL, following construction of R2 without a fine tip).

The problems met in integrating R2 and T2 into a station have been more numerous. Receiver squeal was experienced on ssb transmit in spite of the built-in muting. While K7RO suggests cutting the speaker wire on transmit, this prohibits hearing cw sidetone through the speaker. Instead, it was enough to use a relay to break the receive antenna connection (this had to be done *inside* the receiver) during transmit. Considerable thumping is still audible on cw. This is audible even if the speaker is disabled by the 12v transmit voltage. A more sophisticated receiver muting system incorporating sequencing is needed.



The AA6UL 40M R2/T2 Station

Without a preselector, broadcast band breakthrough is occasionally heard on R2. Plenty of AC hum is also audible in R2 when using a plug-in power supply. However, deep cycle batteries are used at AA6UL, so the usual remedies have not been attempted.

The builder may find it convenient to run the12v ptt line and the 12v keyed line through diodes to a single jack to provide12v on transmit for both cw and ssb. This voltage may be used for such things as the vfo offset and switched linear stages. (The last two stages of the Hands amp are switched on at transmit, to conserve batteries. The preamp for T2 is also powered this way.)

The simplest of the quadrature phase shift networks described by KK7B was used. With this primitive network (as constructed at AA6UL), weak images are audible in R2 when listening to strong signals. Also, a bit of opposite sideband remains on the T2 output.

There is plenty of opportunity for further experimentation, and improvement of performance! That is the nature of the R2/T2 project. Nevertheless, many enjoyable ssb contacts in several states have already been made with this setup, as-is. 72, Ralph AA2UL

NorCal QRP Club Membership List

Our membership is now over 1000. There have been many requests for a listing, so here it is. We will print it again when it reaches 2000. The number is your NorCal #.

Abe	Ron	KM6HO	891	Beckman	Steve	N3SB	366
Abrams	A.L.	N1AFJ	703	Behrens	Joerg		550
Adams	Chuck	K5FO	40	Bell	Bob	K8VOR	79
Adams	David	KG0IO	206	Bellerive	Darrell	VE7CLA	938
Adams	Mark	W6DVO	416	Beltrani	Paul	N2KZZ	103
Adams	Frank		937	Bennett	Lloyd	WA0WOD	724
Addison	Richard	KD6BOR	975	Benson	Dave	NN1G	62
Adkins	Walter	N7EQN	1006	Benterou	Jerry	KK6WB	912
Affrunti	Bob	AA9MI	859	Bergeson	Hal	W0MXY	582
Agee	Lester	W5OQU	755	Berlyn	Robert	N1PWU	305
Ahrens	Tim	WA5VQK	220	Bertaud	Adele	KE6HKY	829
Airola	Virgil	W6RXK	628	Bevilacqua	Giovanni		858
Alexander	Hayes	KD6ZBQ	67	Bible	Steve	N7HPR	254
Alit	Daniel	WD0CGA	275	Bickers	Diane	N6DOD	883
Altzman	Jerry	KE3ML	693	Bickers	Larry	KA6OTM	884
Ames	Alan	N2ALE	317	Bishop	Bruce	K6OY	332
Amundsen	Johan	LA7FF	698	Biskup	Dick	KN6CY	720
Anderson	Jeff	WA6AHL	405	Black	Vic	AB6SO	41
Anderson	Wade	KB5EK	682	Blake	Hank	WD0CFE	152
Anderson	Richard	N6LIM	839	Blakely	Dan	KB6MHN	362
Andrews	Bob	K3QXH	652	Blanke	Kit	WA6PWW	97
Antasek	Jenny	KD6KKP	594	Blaszcak	Chet	KF2QY	663
Antezak	Ernest	NC8N	472	Bliss	Larry	KK6MF	166
Anthony	David	W5HOE	207	Bogusko	Tom	WB3FYU	715
Appel	Cliff	WB6AWM	740	Boland	Michael		786
Applegate	Dale	KA6JFF	87	Bonavita	Fred	W5QJM	69
Applegate	Charles	KC5HGP	869	Bonbright	Bruce	KD6IPX	139
Arbogast	Dan	N0DA	965	Boschma	Brian	KK6FJ	175
Arland	Rich	K7YHA	483	Bosslet	Ronald	N1IUD	261
Armstrong	Ted	KA6LCL	836	Botkin	Dale	N0XAS	856
Arnett	Stanley	AC8W	491	Bottom	Dave	KD6AZ	726
Austin	Tim	K4KVK	289	Bowers	Stewart	WB6FBB	538
Avila	Ed	WB6SDW	38	Bowman	Tom	WA3REY	665
Babu	Prakash	VU2FPZ	945	Boyd	Dale	KD6PYQ	747
Bailey	Mark	KD4D	191	Boyer	Richard	N7VLU	656
Bailey	Cameron	KT3A	232	Bradley	Dave	W6CUB	120
Bailey	Lynn	K5AVJ	410	Brady, Jr.	George	AB6OZ	832
Baker	Hall	N6SYW	83	Brauer	Howard	WD6GNE	908
Baker	Glen	WA2IWM	754	Braun	James	KB2GWF	442
Baldwinson	Richard	N6ATD	825	Braver	Kurt	HB9AMZ	621
Ballinger	Rusty		898	Brittingham	Arthur	W4MPT	345
Banks	Fredrick	AA0QB	591	Broadwell	Chuck	W5UXH	264
Barad	Len	K5LB	678	Broderson	Dwayne	AA7QH	271
Barbe	Doug	KA6WQE	322	Brown	Henry	W6DJX	546
Barglowski	Jan	KC6UTH	144	Brown	Jerry	N4ED	637
Bargmann	Nate	KA0RNY	684	Bryant	Stewart	G3YSX	745
Barham	James	KC5DSP	439	Bryant	Barry	KA2OYF	913
Barnes	John	KE4HBM	759	Bryce	Mike	WB8VGE	487
Barnett	Clyde	KB4CUQ	1005	Bucci	Paul	K9NO	590
Barnhart	John	W8ZRI	631	Buettner	Peter	KC8ER	518
Barrett	David	VE7PCC	727	Bulger	Joe	AA6WG	455
Barton	David	AF6S	796	Bull Young	Nils	WB8IJN	616
Bates	Eric	AA8MD	210	Bunavage	Ed	KA3YAA	311
Beakin	Rod	NR7E	239	Bunyan	William	VE7JO	573
Beaudry	Jim	N6JUG	225	Burdick	Wayne	N6KR	3
Beck	Roy	N6IPS	749	Burgoon	Rob	AB6NZ	847

Burke	Ed	KI7KW	790	Cranston	Scott	KB1NW	179
Burkett	Larry	WA7SOU	47	Crocevera	Frank	KD6HXU	374
Burleson	Cecil	No CALL	528	Cronenwett	Mark	KA7ULD	27
Burniston	Dave	VE3LFO	434	Cronenwett	Larry	KA7WXN	165
Burnley	John	NU0V	1004	Crowell	Edwin	W5TWR	919
Burns	Bill	WA6QYR	788	Crozier	Roy	KE0UQ	57
Bushnell	Nate	KD0UE	560	Crutcher	Ken		524
Butcher	Ron	AA6D	173	Cummings	Stan	AA6DK	85
Butler	Ralph	K6ZAN	93	Curran	Tom	W7UAB	395
Butler	Ray	WA4KEJ	503	Currie	Mike		769
Button	Hollis	WF6U	59	Curry	Daniel	WB6STW	686
Buttschardt	Cliff	W6HDO	250	Cutter	Bob	KI0G	561
Cadigan	Tim	WC1F	713	Czuhajewski	Mike	WA8MCQ	387
Cahn	Howard	WB2CPU	234	Dabkoski	Joseph	WB6QKU	61
Campbell	Roy	KN6QS	458	Darragh	Scott	KE6MGW	875
Carey	Dave	N3PBV	714	Datwyler	Doug	WR7O	163
Carmichael	Ron	KD6RFI	336	Davis	Leon	W6UGT	545
Carpenter	Russ	AA7QU	658	Davis	Peter	G0RFZ	719
Carreiro	Paul	N6HCS	367	Davis	Palmer		923
Carrington	Jim	KD6JTY	551	Day	Geoffrey	KB6GSA	929
Carter	John	W5LGO	623	DeGrazio	George	WF0K	204
Carter	Floyd	K6BSU	760	Delateur	Louis	KA6PLL	209
Caruso	Sal	KC6WTO	978	Demmer	Peter		685
Cates	Jim	WA6GER	1	Deovlet	Ben	W6FDU	872
Cates	Steve	KC6TEV	31	Derk	Lamar	N3AT	989
Cepluch	Robert	AA8LJ	934	Despain	Keith	AB5QE	132
Chan	Loren	WA6ENC	48	DeVaughns	Lloyd	KD6FJI	12
Chandler	Andrew	N6JTX	955	Dezelski	Hans	DL1SDZ	849
Chandler, III	James	N0VAH	157	Diana	Gary	N2JGU	287
Cherry	Myron	N5ZPB	659	Dickens	Richard	KY0Q	735
China	Myrun	KB0LMQ	589	Dickerson	Lewis	K6BPB	386
Christensen	David	K7BWZ	194	Dickey	Paul	N6JOX	905
Christensen	Paul	N9AZ	982	Dicks	Colin	ZR6AMK	578
Christian	Paul	KN6OJ	371	Diehlman	Fred	AE6G	383
Churchill	Don	K6EIX	961	Dobbs	George	G3RJV	433
Clark	Keith	W6SIY	53	Doherty	Robert	K1VV	848
Clayton	Rodney	KA3BHY	237	Dolson	William	K8DDV	500
Clayton	Dan	K6DFF	352	Dolson	Jim	WB8ZBD	501
Cleveland	Grover	WT6P	216	Domenici	Eugene	AC4ZY	389
Clifton	Craig	N6BWJ	312	Dooley	Mike	KE4PC	75
Cockerell	Larry	W5HDD	827	Dorn	Don	KJ5MG	676
Colaguori	Tony	W2GUM	344	Dorner	George	W9ZSJ	326
Colgrove	Scott	KD6VEE	397	Doudera	Petr	OK1CZ	432
Collins	Mike	KC6SEG	32	Drake	David	K8BRX	363
Collins	John	KN1H	972	Drake	Ted	W5TB	1002
Comas	Andrew	KF2JH	353	Draper	Robert	VE7IEI	761
Conley	John	W7ZFB	930	Drummund	Budd	WJ6Q	954
Conly	Ralph	N6VT	108	Duckett	N.E.	W6LYG	306
Cook	Tim	NZ8J	267	Dumond	Bill	KA7EGX	541
Cooper	Stan	K4DRD	5	Dunham	Sheldon	W4OEL	76
Cooper	John	KJ5CR	447	Dyer	Bob	KD6VIO	8
Corbin	Lowell	KD8FR	493	Ea	Dara	N6YJS	373
Correia	Dan	WB6RDR	236	Earlix	Larry	KC6JEV	58
Cosma	Richard	KD1BF	471	East	Larry	W1HUE	756
Couger	Gordon	AB5OG	764	Easton	Bob	N2IPY	606
Craig	Greer	AA5HN	646	Eaton	Chandler	W1IFL	74

Eaton	Peter	WB9FLW	286	Frisz	Tom	N9DD	342
Eaton	Doug	WN6U	831	Fry	Jery	KD6WSF	429
Ebbett	Walt	KB6QIB	240	Furman	Jeff	KD6MNP	28
Eddy	Mark	KN6PW	22	Furman	Mike	KD6OCS	138
Edwards	Ralph	KG7YS	319	Furnweger	Charles	WB4OWL	522
Ehrlich	Murray	K7AU	320	Furtado	Art	KG6PY	372
Ellis	Jerry	N2XHY	675	Gains	Smokey	KN6AE	270
Elrod	Jim	WB6WLU	241	Gainsborough	John	KM6LJ	868
Englander	Denis	KD6ETI	34	Gallagher	Thomas	N6RA	457
English	Bill	N6TIW	221	Galloway	Maurice		562
Enos	Mervin	N6FZS	106	Garcia	Greg	WB6DAI	552
Erickson	Ronald	AK0N	413	Garland	Harold	KD6ZDO	595
Ermisch	Paul	No Call	282	Garrison	Karen	AA1AH	973
Esheim	Ed	NK6I	104	Gauding	Dave	NF0R	159
Evans	John	N3QOO	262	Gavin	Michael	WB6KJE	799
Evans	Gary	AA6R	358	Geer	James	WB5LXZ	596
Evans	David	G4YND	699	Geitgey	Lynn	KB0LRB	399
Evans	Evan	AA2AA	852	Gellatly	Bruce	VE7ZM	533
Everhart	Joe	N2CX	707	George	Allen	N6PFL	115
Everly	Jim	K8IKE	474	Gervais	Joe	KD6PRD	779
Falcone	Joseph	AA8HV	318	Ghysels	John	KE6MCN	819
Fancher	Don	K6TCP	985	Gibson	John	N6OM	164
Farnworth	Bob	WU7F	365	Gibson	Stephen	WB4NBI	611
Fassiotto	Marco	IX1IIY	202	Gibson	Dwain	WA0ZPT	627
Fauchier	Dennis	KB0GRD	762	Gilman	Leo	WD6ALJ	600
Feeney	Kevin	WB2EMS	192	Gingell, Jr.	George	K3TKS	426
Feick	Lawrence	NF0Z	324	Gjernes	T.A.	VE7PA	718
Feldman	David	WB0GAZ	921	Gleason	John	N6GRJ	887
Fenech	Bill	AA6ZK	626	Glines	Richard	WQ1T	146
Ferguson	John	N1IPT	340	Gobrick	Robert	WA6ERB/VE2DRB	88
Ferme	Vincent		343	Gold	Jeff	AC4HF	39
Ferranti	Rick	WA6NCX	45	Goldstein	Stan	N6ULU	252
Fields	Tom	WB9VTY	477	Goodwin	Dan	KA1JML	448
Fiford	Charles	KD4YLG	1001	Goodwin	Dave	N0UNH	768
Finch	Bob	N6CXB	479	Goosey	Mal	AA7WT	278
Fiorello	Carmine	AB6KE	134	Gormley	Pat	KB6HZM	49
Fisher	Richard	KI6SN	37	Gouldie	Jim	AF3Z	784
Fisher	Bob	KA3ZSU	398	Grabowski	Eric	WA8HEB	293
Fisher	Michael	WT9W	977	Graham	Dwight	WA6NAE	870
Fitton	Jim	W1FMR	137	Grasso	Gerald	WW0G	695
Flack	David	W0RNL	525	Graves	Bill	N7TDK	99
Flanagan	Mike	KB8NKX	709	Gray	Rand	W1GXN	265
Fleming	John	N9NDH	854	Gray	James	W1XU	580
Florip	Bruce	AA7AR/6	11	Greenwood	Greg	WB6FZH	71
Flower	Dan	KE6DMS	420	Gregson	Roy	W6EMT	263
Fluesmeier	A.L.	KE7IT	269	Gruen	Huston	K7ITA	208
Flusche	Anthony	AB6BR	140	Guinn	David	KO4MC	736
Forbes	Ross	WB6GFJ	351	Gunn	Ruffner	KE6KTP	840
Fox	Geoff	WA1U	187	Guo	Lisa		553
Fox	Larry	KG7BA	226	Gustoff	Mark	WO7T	141
Frances	George	W3ASE	979	Haas	Edward	W7RK	572
Francis	Patrick	N1OCJ	171	Hagar	Robert	KI7HW	780
Francoeur	Jim	KC1FB	81	Haik	Vern	KJ6OG	19
Franklin	Bruce	KG7CR	377	Hale	Jim	KJ5TF	990
Franklin	George	W0AV	981	Hambrick	Ronald	N5SBN	605
Friend	Steven	AC6CL	792	Hamer	Arvid	WA6UUT	826

Hamilton	Keith	NO8Z	215	Huffstetler	Don	WA6OUW	993
Hamilton	James	AC4AS	470	Hurd	Edgar	W6TAD	584
Hammond	Noel	KK6AL	248	Hurwitt	Mark	K6CQD	156
Hammond	Frank	KC4GKY	334	Hutchins	Lee	KA6IRL	526
Hardie	Peter	VE5VA	290	Hutchins	Eric	KE6IIY	805
Harger	Elmer	KM6FG	520	Hutchinson	Paul		688
Haring	Dave	WL7DB	672	Hynd	Bob	N5URL	597
Harold	Steven	KA2FDS	866	Hysell	John	KF2XC	219
Harpen	Martin	KK4RF	635	Icou	Dave	KD6AEH	897
Hart	Gary	WL7KV	998	Irish	Wesley	WA2CRQ	952
Hartford	Cam	N6GA	52	Irons	Ralph	AA6UL	55
Harton	Paul	W5ILN	460	Isler	Carl		697
Hartshom	Lloyd	N6DOK	117	Isseks	Barry	AC6HV	927
Hartwell	Marty	KD8BJ	844	Iza	Jon	EA2SN	701
Hastings	Larry	WB0AKE	767	Jadoon	George		877
Hatton	Peter	N6JBV	816	Jaminet	John	W3HMS	456
Haynes	Richard	N5QXF	601	Janssen	Willi	DL1BJI	641
Hayward	Wes	W7ZOI	300	Jarchow	Mike	KE6HD	68
Heacock	Doug	AA0MS	296	Jennings	Tom	KV2X	190
Headrick	Bob	WA7OVU	174	Jentges	T.W.	W6ALO	771
Heath	Gregg		298	Johns	Jim	KA0IQT	145
Hebert	James	KA8OUT	364	Johns	Clarence	KC6LIJ	704
Heise	Jan	WA4VQD	184	Johnson	Dave	WA4NID	355
Helfen	Mark	KM6FM	35	Johnson	Byron	WA8LEZ	838
Helms	Robert	AF5Z	508	Johnson	Howard	WD4FXX	671
Helton	Ernest	W8MVN	490	Johnson	Dan	KC4EYT	963
Hemphill	Dean	KC5NG	634	Johnson, Jr.	Peter	KN6MO	388
Hendricks	Doug	KI6DS	2	Jones	Darrell	WD6BOR	17
Hendricks	Kerry		531	Jones	Jeff	AB6MB	65
Henry	Steve		865	Jones	Chris	N7ZWA	309
Herr	Mike	WA6ARA	50	Jones	James	K9PNG	440
Herrschaft	Paul	KQ6G	253	Jones	Larry	N5OSG	481
Heusser	Robert	K6TUY	384	Jones	Wil	N5VHY	683
Hian	Tan Boen	9V1ZH	574	Jones	Tom	KR2V	787
Hicks	Greydon	KC6SLE	807	Jones	Charles	AA4XO	855
Hideg	Steve	N8HSC	323	Jones	Fred	WB4BDS	935
High	Rich	W0HEP	327	Jones	William	N5DOX	950
Hill	Jim	K6UUW	841	Jones	J.L.	N9KXB	995
Hiser	Ernie	AB6PP	283	Jose	Ed	N6ICG	892
Hodgson	Richard	WI6D	687	Joseph	David	WA6BOY	26
Holmes	David	K4UMI	437	Jue	Martin	K5FLU	222
Holmes	Vernon	KG5HD	636	Jumper	Mike	KC4DIZ	245
Holmes	Marv	W0YHE	639	Kahn	Arthur	W6NJY	666
Holt	James	KM6MO	131	Kaidor	Jerome	KF6VB	168
Holzknecht	Ralph	W6RVY	149	Kampa	Paul	KB2HAA	466
Hoogasian	Harold	WB6WAS	815	Kaps	Nicholas	K6DIW	4
Hoover	Pete	W6ZH	609	Karty	Steven	N4UHO	391
Hopkins	Michael	AB5L	581	Kashuba	Mike	KI6OI	295
Hornberger, Jr.	Robert	WA5DRQ	200	Kasin	Bob	KA5MIZ	625
Houf	Bob	KD9UX	649	Kastigar	Matt	N0XEU	706
Howard	Richard	KM6QW	154	Katz	Damon	KE6BXY	604
Howard	Ralph	WD6BGN	804	Kaul	Alan	W6RCL	315
Hrudetz	Al	W5QEE	273	Kearney	James	KB8GDN	516
Hubla	S.	KE6KGT	943	Keen	Albert	KI6UY	994
Hudnall	Robert	N5ZRD	766	Kees	Eric	N7HWW	430
Hudson	Kenny	K5QLP	700	Keeton	Burl	N5DUQ	274

Kehr	Bob	KA9MDP	970	Lee	Gene	KB7GIR	233
Kell	Ted	KC5CUW	203	Lee	Robert	K8RL	669
Keller	Robert	KB6OHO	148	Lee	George	K5HT	795
Kelley	Michael	N6VNE	514	Lee	David	KF6MP	850
Kellner	Richard	W5RXP	563	Legge	Bill	NT1R	705
Kelly	Don	KA5UOS	599	Legrand	C.C.	AH6CS	889
Kelsey	Bill	N8ET	43	Leinau	Bob	W7BD	763
Ketterman	Charles	K6EN	33	Leinweber	Glen	VE3DNL	800
Keys	Phil	KB7WXP	664	Leitner	Bernard	KE6BYA	565
Khan	Hamid	N7OLJ	757	Lemoine	Dana	KB7WSW	615
Kiespert	Brad	KG5UK	752	Letsinger	Dewey	KN6WU	549
Killer	Ed	W6UDY	906	Lewallen	Roy	W7EL	467
Kimball	Dennis	KB6VFC	738	Lewellyn	Stanley	W4HCN	396
King	Jerry	W4MLA	310	Lewis	Warren	KD4YRN	180
Kirby	John	N3AAZ	640	Ley	Hary	KC6PDC	423
Klarer	Herb	WB6VGC	880	Libby	Albert	KB1FK	690
Kline	Richard	WB3BLM	475	Liebenrood	John	K7RO	723
Knochenhauer	J.D.	K6ITL	873	Liencres	Bjorn	KN6IW	953
Knudson	Doug	KB6ZMQ	281	Lifter	Bruce	KR4AQ	185
Koch	Eric	NF0Q	482	Lindley	John	W6YOY	974
Kohl	Kerry	KN6NF	394	Linstruth	Wally	WA6JPR	842
Kohl	Hank	K8DD	492	Litchfield	George	KB2NVN	257
Koller	Edward	W6UDY	971	Little	Dave	AF5U	461
Koretko	Paul	WA0BAG	509	Littlefield	Rick	K1BQT	465
Kors	Dick	KM6EP	121	Lockwood	Bob		506
Korte	Bob	KD6KYT	619	Logan	Bob	NZ5A	205
Kosa	Bob	N5LCO	729	Logullo	Jeff	N0MII	992
Koseh	Larry	K8EJU	939	Long	Ray	KD6GLS	229
Kowalsky	Richard	N7RAY	235	Lorenson	Don	KN6LG	821
Koyle	Myron	N8DHT	406	Lucas	Robert	WD5IBX	680
Kozlovsky	Don	KE9GG	480	Lucchesi	Richard	WA2RQY	957
Krampbell	Mangus	SM7IFU	585	Luck	Rodney	VE7ESA	991
Kraus	Howard	K2UD	924	Ludwig	Loren	KG0HM	452
Kremer	Karl		195	Luscomb	David	AB5JE	450
Kretcmer	Joseph	WA9WIG	710	Lutz	Peter	AB6AV	846
Kretzschmar	James	N4HCJ	112	Lyon	Tony	KJ5XF	853
Kubisch	Steve	WW7Y	258	Lyons	James	VE2KN	510
Kuhl	Stan	K6MA	114	MacDonald	Duncan	VE6DMD	588
Kuhn	Charles	N9NVV	643	Magirian	Raymond	K4DHC	633
Laas	Rod	KN6DA	307	Magnusson	Paul	W7MYA	830
Labutski	John	KD6VDU	158	Magro	Dan	KV6I	91
Lai	Bob	KM6QP	96	Maguire	John	GM0PQV	721
Lai	Larry	BV2BJ	673	Mahler	Chuck	KN6WW	102
Lakenmacher	Dan	N5UNU	302	MaHoney	Ken	K6OPG	127
Landon	Kalman	WD6CZI	178	Majewski	Ron	WB8RUQ	183
Lang	Gary	WN9U	411	Malzone	Louis	AC6BC	645
Lanning	Bob	W6OPO	381	Manabe	Ron	KN6VO	122
Lanyon	Fred	WB0OTP	614	Manuel	Ed	N5EM	498
Larmon	John	WE2H	843	Marandos	Dennis	K1LGQ	272
Lauri	Frank	KD2IX	412	Margeson	Eric		837
Lawson	Bart	NZ5T	679	Margot	Alan	N6BXU	547
Lawyer	Bruce		511	Markle	Jim	KB5OB	583
Le	Thang	AA6SV	321	Markovitz	Herb	N7OGI	817
LeBarge	Craig	WB3GCK	566	Marlan	Bob	KA6NOC	277
LeBarts	Kent	KK6IU	18	Marlin	Bill	KD6LTA	810
Lee	Stephen	KC7AVB	182	Marmor	Michael	AA2UJ	997

Marsh	Harry	W6TFQ	314	Moeslchler	Loren	W6KGS	109
Marsh	Doug	N8TUT	739	Moffett	LeAnne	KC5KKQ	948
Marshall	Gene	AA6IY	36	Moffett	Paul	WB5VZI	949
Martin	Emil	K6MJ	532	Mohan	Sam	KB3BEA	984
Martin	Davis		734	Moizeau	Charles	W2SH	692
Martin	Stephen	NK3R	925	Moneysmith	W.G.	W4NFR	495
Maslyukov	Vasili	UA0SN	750	Montilla Guerrero	Miguel	EA3EGV	620
Maxwell	Jim	W6CF	288	Moore	Jim	KD6TAX	378
McClure	Bud	K5IUD	667	Moore	Larry	KM6IU	424
McClurkin	J.L.	W7JDZ	100	Moore	John	AB6DL	425
McCoy	Bill	KE4JSU	733	Moore	Douglas	KC5ZF	681
McCuistion	Mark	KB2ELS	964	Moreno	Robert	KE6GTI	548
McDonald	D.J.	K6AGN	101	Moresi	Bill	N6FER	238
McDowell	Jeff	N0WCE	504	Morgan-Davie	Keith	N2MUU	193
McElroy	Jim	AA3BZ	629	Moriarity	John	K6QQ	851
McGahey	Gene	AL7GQ	89	Morrison	Walt	W2CXY	956
McGinnis	A.	WA2DTP	648	Morrisroe	Jack	KA6GZA	414
McInnis	Ron		732	Mount	Robert	KB6MHS	449
McIntosh	Jeffrey	G7ILM	806	Mukai	Thomas	WB2STR	9
McKee	Jim	KK6SD	833	Mull	Larry	KB7ZNE	129
McKinnie	Paul	W6ERB	119	Mulvey	Rich	N2VDS	213
McLellan	Scott	ND3P	198	Murphy	Dennis	KB6LZW	125
McLeman	Jeff	KD1IT	443	Murphy	Jack	KB7PLT	507
McNamara	Richard	KD4UGC	602	Murphy	Robert	W3HJJ	530
McTaggart	Kenneth	N6KM	231	Murphy	J.M.	KB7PLJ	555
Meacham	David	W6EMD	339	Murray	Bill	VE7YY	915
Meacham	Doug	KC6VKT	879	Muscolino	Bruce	W6TOY	473
Mead	Earl	AB6CN	820	Nagai	Kei	AB6SS	818
Meadows	Jack	WD7I	554	Nagata	Ron		986
Meahan	Bill	WA8TZG	407	Nagle	Frank	N6NQY	116
Meier	Pete	WK8S	478	Nakayama	Curt	KH6LE	153
Meltier	Randy	KK6TQ	111	Nameny	Bill	K6SL	902
Melton	Ronald	N7NIQ	329	Narramore	Gary	N6YBD	14
Menard	Glenn	KK6ZC	66	Neece	Robert	N4JED	758
Mensing	David	N2PSH	244	Neindorff	Richard	WB2RAR	167
Meyer	Frank	KE7OF	285	Nellis	Albert	KA8IPO	496
Meyer	Tom	WB5OLA	789	Nelson	Tom	KD6EVM	161
Michael	D.A.	W3TS	540	Nelson	Larry	KC6NYG	907
Michnay	Dan	K9EA	567	Neverdosky	Mike	N6CHV	996
Midkiff	Monte	N7TAV	730	Nichols	Todd		593
Miers	John	KN6HG	110	Nordquest	David	KE9ED	632
Mikkelsen	Tom	WA0POP	476	Norris	Jim	N9RKB	212
Miller	Mike	WB6TMH	16	Nystedt	John	KC7AKW	607
Miller	Chris	KD6WUC	95	O'Donald	Gary	WB7TXN	304
Miller	Forrest	N6ZBZ	124	Okas	Bob	N3MBY	189
Miller	Steve	KG7PV	308	Olheiser	Ed	WB6LRV	558
Miller	Bob	WA6KTK	382	Olson	Brian	N0XFE	356
Miller	Alan	N6VYI	436	Olson	Carl	W6QYO	421
Miller	John	WD5HZE	438	Ontiverous	Rob	KC6ZTT	113
Miller	Randy	WA0OUI	486	Osinski	Mark	N9VHY	513
Milne	Bruce	WB2QAP	260	Ozment	Bill	W6SLW	328
Milos	Frank	NO1E	259	Pace	Clay	WA6FDF	279
Miner	Bill	WG6H	445	Pacyna	Ed	W1AAZ	176
Mitchell	Brad	WB8YGG	346	Page	Chris	G4BUE	468
Mizrahi Shalom	Ori	AC6AN	441	Paine	Bob	W7RX	368
Moeller	Ron	K8BPN	21	Palings	Walter	ON4PX	333

Palmer	Ken	KK5DB	864
Parker	Jerry	WA6OWR	172
Parker	Paul	WB6DHH	822
Parmley	William	KR8L	454
Pascoe	Dick	G0BPS	338
Pattison	Richard	VE7GC	568
Paul	Bil	KD6JUI	256
Pavao	Alfred	KD6EFV	651
Pearcy	Bob	N6USN	177
Peavey	Howard	K9PV	408
Pellizzoni	Fabio	IK2LEY	708
Pelt	Ransom	NZ4I	774
Penc	Richard		746
Penn	Jason	N9RPT	347
Pepper	Jim	W6QIF	42
Pepperdine	Brien	VE3VAW	539
Percival	John	WI6O	803
Pereira	Mark	WA1JVY	712
Periat	VJ	WA6PUV	871
Perkins	Roberta	N3CUD	70
Persaud	Nardeo		744
Persson	Erik	VE7HTT	918
Pettibone	Timothy	AB5OU	644
Pfeiffer	Bruce	N7CPP	1000
Pfister	Don	KA0JLF	770
Phelps	Randy	KD8JN	485
Philpot	Frank	KE8MM	488
Pickett	Chris	KE6FAW	571
Pierce	Mont	KM6WT	135
Pierce, II	Edwin	KZ6Q	564
Pion	Albert	KE6HKU	885
Pituch	Steven	N2MNN	691
Plesich	Joe	W8DYF	988
Ploss	James	KB6MYV	828
Point	George	K2BEV	932
Polen	David	W8FRB	303
Polizzo	Phil	KE6MSL	824
Pope	Jim	KA0JJK	579
Potma	Charlos	PA3CKR	575
Povlick	Timothy	WA3INX	662
Powers	Dennis	AB6QR	557
Pratt	John	N1UA	536
Pridgen	Terry	KC4YTF	349
Prior	Greg		946
Priori	Gabriele	I6QGA	655
Pulley	Mike	WB4ZKA	958
Pulliam	Foy	KK6UM	418
Purcell	Kevin	N7WIM	63
Quagliana	Doug	KA2UPW	128
Quick	Paulette	N9OUH	942
Quigg	Daniel	WD4IRK	668
Rainbolt	Bob	WB0AUQ	765
Rand	Randy	AA2U	400
Ratzlaff	Steve	AA7U	105
Ray	Martin	NN9H	299
Rea	Al	W8LRM	246
Read	John	KK6OQ	390
Read	Brian	2E0AEQ	737
Redfem	Dave	N4ELM	162
Reeve	Rick	VE3ORY	743
Rehm	Eric	KJ7AE	542
Reid	James	KD3S	435
Reid	Glen	K5HGB	660
Reid	Ken	KE6MZA	947
Reimers	Fred		613
Reistetter	Andy	K6RYN	227
Rench	Mike	N6TMR	143
Reynolds	Robert	K5VOL	409
Richardson	Clark	AH6LC	890
Richmond	Richard	N4AFX	463
Rieger	Dennis	KK5DB	863
Rioux	Michael	NW1J	777
Robinson	Michael		857
Rodgers	Bill	K3HZP	462
Rosen	Marvin	N3BQA	243
Rossi	Robert	W2HG	325
Russell	Brian	G0NSL	689
Russell	Dick	KJ5VV	944
Rutledges	Craig	KB6XV	427
Rybak	Jim	W0KSD	638
Sachs	David	AA9GF	517
Sage	Brad	K6JPR	910
Salas	Phil	AD5X	297
Salek	Stanley	KD6CVL	80
Salony	John	WA3SRE	469
Sammut	Charles	K8MI	1003
Sanderson	Duane	W0TID	370
Sawtelle	Benjaman	N6PJZ	702
Scherkenbach	Jerry	N9AW	499
Schiller	Matthew	KD6BWE	123
Schlottman	Al	KL7CVP	284
Schmeichel, Jr.	Robert	N1RXV	951
Schmidt	Fred	N0JFJ	544
Schuman	Allan	AA6ZL	899
Schutte	Ralph	N6NAD	529
Schweitzer	Robert	WB7QNB	968
Scott	Robert	AC4QO	133
Seaman	Robert	KC6HPH	291
Sedlar	Frank	WB6KFB	926
Seeno	Terry	N6YQD	150
Sellers	Gabe	K60NR	647
Selman	Larry	AA6MU	249
Semorile	William	W6LNG	60
Serlin	Omri	AA6TA	559
Server, Jr.	Tom	KB6LUC	94
Servidio	Art		577
Severin	Ken	WL7HU	791
Seyle, Jr.	Melvin	WA3KZR	392
Shaffenberger	Paul	KD8N	576
Shalita	David	W6MIK	354
Shank	Greg	KE6EAT	900
Shanney	Bill	KJ6GR	136

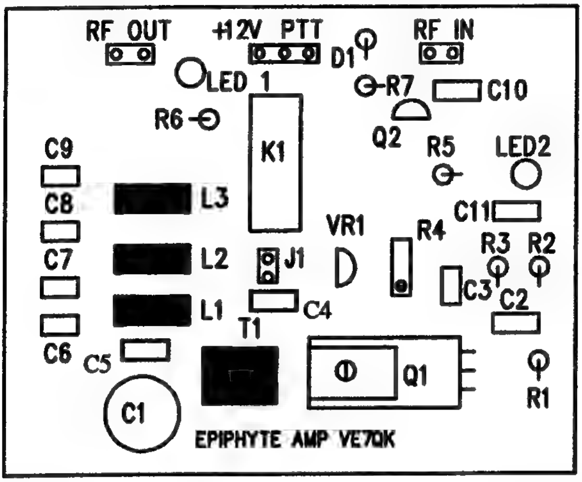
Shashinda	Robert	KE6DHE	835
Shattuck	Les	WN2V	422
Shearer	Stephen	WB3LGC	794
Shelhamer	Mark	WA3YNO	196
Sherman	Richard	WZ2T	393
Sherrick	Mike	NZ7G	834
Shipman	Don	W3RDF	521
Shireman	Chris	KD6WOV	657
Shore	Randy	KC6AND	13
Short	Doug	KD6SAU	895
Shortz	Bill	KA9BZM	86
Shrader	Eric	KC6SPN	731
Shulman	Jack	W6EBY	78
Siegel	Mike	KI6PR	29
Silverwood	Tom	W6DJ	403
Skelley, Jr.	Jack	WA2SST	920
Skolaut	Charles	K0BOG	622
Slade	David	K2SJB	335
Slavinski	Francis	KA3WTF	610
Sliger	Ed	AB6NA	385
Sminkey	Scott	WO1G	586
Smith	Bob	KD6FVI	25
Smith	Rusty	KD4GLC	77
Smith	Trevor	AB5EU	130
Smith	J.C.	KC6EIJ	255
Smith	Wayne	KN6EY	459
Smith	Bill	WA6YPE	512
Smith	H.W.	W4INQ	728
Smith	J.R.	WA7ICC	941
Smith	Harry	NA5K	967
Smith	Dennis	WA4FVQ	976
Smith	David		980
Smoler	David	KE6AJL	292
Sopha	Bill	N8SWQ	502
Sorge	Robert	KC5FMZ	793
Souligny	Allan	WA7SNV	808
Sparlin	Douglas	N6PYW	268
Spencer	Fred	KG2K	798
Spencer	Len	WA6CBQ	809
Spittle	Derry	VE7QK	543
Spitzer	Norm	W6LWR	814
Splaine	Bill	N6GHG	126
Spoonhower	John	KC2DU	224
Sposato	Vince	N2AXV	654
Springer	John	KI6PU	931
Squicciarini	Martin	NR3Z	186
St. John	Paul	N6DN	940
Stackhouse	Ken	WB4IAI	316
Stackhouse	Charles	WA2IPZ	341
Stade	Wayne	N6LQA	107
Stanford	Lee	KM6LA	725
Stanich	Nick	N8AAN	497
Stanley	William	KD6GMF	24
Stark	Monte	KU7Y	330
Stefanik	Stan	VE7STN	464
Steimetz	Calvin	KD6WNM	211
Stein	Michael	KC6YSR	197
Steinhour	Gary	N6DZA	10
Stelwagon	Frank	KD6TNF	350
Stempek	Ron	AB6QP	142
Stem	Rick	AA6BS	903
Stevig	Dan	KA7QJY	160
Stewart	Holly	KD5DL	677
Stibal	Thomas	W0PNS	776
Stockero	Ernest	W6SB	228
Stough	Bruce	AA0ED	670
Stracqualursi	Larry	W1HMD	556
Strang	Jim	N6WTL	23
Street	Nancy	KE6HLU	785
Stuehler	Rick	N6ZFT	375
Stuntz	Stephen	K6FS	936
Stutler	Adrian	AC4IT	987
Sugden	David	G3MAM	694
Sullivan	James	KA5FBC	742
Supplee, Jr.	Dan	N7NBW	218
Swanson	Scott	K6PYP	90
Swartwout	Mark	NX1K	230
Swartz	Eric	WA6HHQ	251
Switzer	L.T.	N8CQA	494
Switzer	Emil	W1GGM/4	587
Syd	Furman	W6QWK	823
Szymaniak	Bernard	DL7GK	722
Tanaka	Marvin	KH6MM	118
Tatum	Robert	WA5THJ	969
Tavan	Richard	N6XI	170
Taylor	Greg	KD4HZ	294
Taylor	Leland	KD6UOQ	428
Tellefson	Bob	N6WG	813
Tendams	Pat	WS8T	266
Ter Sarkissoff	Mike	N6DBZ	535
Thearle, Jr.	Al	WB6RUU	415
Thomas	Walt	WA4KAC	523
Thomas	John	WX7R	650
Thomas	Mike	KE4LAU	653
Thomas	Dick	AB6TJ	748
Thompson	J.B.	AA6IH	402
Thompson	Jerry	AB7DE	797
Thompson	Chuck		928
Thornton	Dub	WA5YFY	598
Tinsley	Ken	WF6H	983
Todd	Bill	N7MFB	214
Tolliver	Grover	KQ4AL	751
Townsend	Jim	K9BXG	489
Traylor	Roger	WB4TPW	242
Treaton	Bernard	KM6TY	446
Treleavan	Dale	VE7UX	917
Trentacosti	Charlie	KJ6MO	98
Treusch	Brian	KJ6LL	15
Trier	Stephen	KG8IH	618
Trigilo	Dan	KF6MU	570
Troster	John	W6ISQ	46
Turner	Clark	WA3JPG	56

Turner	Don	W6ROY	772
Turner	Victor	WA6EIW	862
Turner	Mitch	KN6MJ	881
Turpin	Fred	K6MDJ	51
Turvey	Paul	G1PJJ	44
Ubling	Sam	N4UAU	845
Upton	Larry		569
Utley	Dennis	K7JLF	379
Utley	Jon	KG7TE	380
Valko	Paul	WB8ZJL	778
Van De Velde	Robert		534
Van Derpoel	Frank	K6UIZ	867
Van Nuys	David	AB6XR	901
Vandenheede	Tim	KC6IJE	959
Vander	Mike	KE6HCG	894
Vanderbeek	Herbert	WY6G	811
Varn	David	KM6RI	20
Vaughn	Chuck	AA0HW	505
Von Striver	Jim	W6ASL	882
Waits	Don	N5KLI	624
Walker	Leo	AD5OF	360
Walker	Bruce	WT1M	453
Walker	Ken	VE7KGW	741
Wallack	John	W6TLK	401
Warmke	Robert	W6CYX	7
Watson	David	KE6BWJ	716
Watson	Dan	N6QGI	886
Weathersby, Jr.	Scott	AA5BK	169
Weaver	Jack	KD6ZMJ	896
Weaver	Michael	KG8H	933
Webb	John	W6RCW	812
Webber	Will	KF8XC	147
Webster	Dennis	WJ6H	773
Wee	Daniel		674
Weiss	Adrian	W0RSP	661
Welch	Dale	N6DW	348
Welch	John	N9JZW	592
Weller	Jeff	N2SZE	331
West	Doug	KB5SZZ	276
Westfield	Michael	N6PFK	81
Westphal	John	W8YNA	753
Wheable	Michael	KC6GPY	444
Wheatcraft	Bill	N0WZE	431
White	William	N1OSA	72
White	Joseph	WA4GIR	73
Wicks	Robert	W3HAH	537
Wilber	Don	WD6GYJ	64
Wilhelm	Spence	KB7TCY	188
Wilkerson	Richard	WD6FDD	630
Williams	James	KI6JD	6
Williams	Bruce	N9JVC	359
Williams	Jerry	KB9SZ	696
Williams	KC	VK6KC	717
Williams	F.T.	WA6NSC	876
Williams	Lee	WA6IMF	914
Williamson	Lars	W6RMY	151
Williamson	Art	N0TXT	301
Wilson	Reed	K6JUD	361
Wilson	Stan	AK0B	404
Wilson	Donald	KM6SE	451
Wingert	Brian	N7RVD	199
Winn	Don	AF4Z	313
Winter	Dick	AB6EY	802
Woish	Bob	WB3BJT	603
Wolbert	Bob	N6IP	515
Wold	Bob	K6ZLY	357
Wood	Michael	N6MVE	82
Woods	Jim	KC7FG	155
Woods	John	WB7EEL	181
Woodward	Robert	N6PGQ	417
Wright	Robert	WB7CNJ	201
Wright	Frank	KD6RAL	280
Wright	James	WB5THZ	376
Wright	Vern	W6MMA	419
Wright	Robert	KG7YE	484
Wright	Barbara	KE6HRK	999
Wyman	Mike	WB1CWD	217
Wynn	Clay	N4AOX	337
Yee	Gordon	KI6UH	30
Yip	Stanley	VE7GO	617
Yokum	Roger		247
Young	Bill	WF6D	54
Young	Terry	KC6SOC	92
Young	Robert		916
Zabrodski	Rick	VE6GK	519
Zahos	Stephan	KR4S	960
Zander	Paul	AA6PZ	608
Zarfos	Ben	W3GES	527
Zawalick	Frank	WD6DCV	84
Zemenick	Ted	W8LCR	801
Zentner	Bob	W6UMP	223
Zimmerman	David		775
Zumwalt	Glenn	KJ6EN	874

Corrections to Epiphyte Amp and VFO

by Doug Hendricks, KI6DS
862 Frank Ave
Dos Palos, CA 93620

The December issue of QRPp featured a 5 Watt Amp and a VFO for the Epiphyte. I made a couple of mistakes that need to be corrected in order for the projects to work. First of all the VFO needs to have the trace between C11 and C6 cut. The corrections to the 5 Watt Amp are all my fault. Derry Spittle, VE7QK did a great job of supplying a layout diagram, I just made some mistakes when I put it in the Cad Program. Here is the corrected parts overlay. I apologize for any inconvenience that I have caused.



The changes include a 3 pin connector for the PTT and +12V instead of 2 two pin connnectors, and I forgot to include C4 and C5 in the original parts overlay. 72, Doug, KI6DS

TIDBITS

By Mark Cronenwett, KA7ULD
1029 Duncan Ave.
Sunnyvale, Ca 94089

Have any ideas that you would like to share with others? Well here is the place to do just that. Send your ideas to me at the address above, by packet at KA7ULD @ N0ARY.#NOCAL.CA.USA.NA, or by Internet E-mail to ka7uld@ix.netcom.com or mcron@sgi.com (preferred).

Not to be one to get up on a pedestal, but if you have some little 'tidbit' that you want, or think you can share, please send it to me. I take any and all suggestions. If you are not particularly proud of your writing ability, give me a rough outline of what you want to say, and I will actually work for once, and write one up, and let you preview it. So now you don't have any excuse not to write me. Remember, this column is for you, the member, and comes from you, the members!!!

WARNING FOR KEYER OPERATORS

From: Dave Meacham, W6EMD

WARNING! You may be inadvertently transmitting a dot when you turn on your keyer (or

when you turn on your rig if it has a hard-wired keyer installed. This came to light when I used my OHR WM-1 QRP Wattmeter to check the output power of Stan Cooper's Sierra with different band modules in place. (Stan is K4DRD) Every time he turned on the Sierra the wattmeter kicked up. He has a 1994 ARRL Handbook keyer installed in his Sierra.

Later, at my home QTH, I ran into the same phenomenon with my MFJ-8043-IC keyer, AND, to some extent, with the OHR keyer board installed in my NorCal 40. All of these keyers use Curtis chips.

Some circuits, including the OHR board, have a BS170 (or equivalent) in the keyed-output lead which is supposed to eliminate the problem at initial turn-on if all capacitors are discharged. If you don't wait long enough after turn-off before turning on again, any keyer using a Curtis chip may transmit a dot.

The DANGER looms when you turn on your rig (or the keyer with the rig on) without a load on the antenna connector (as you might do to test the receiver, etc.). With no load you can blow your PA transistor very easily if it doesn't have a zener across the output. You can also blow a signal generator connected to your antenna connector!

A safe solution, at least for the present, is to use an attenuator, dummy load, or antenna on your rig whenever you turn it on (or when you turn on the keyer with the rig on). ... 72, Dave, W6EMD

SPACING COMPONENTS ABOVE A PC BOARD

From: Vic Black, AB6SO

While building my Sierra I noticed that the crystal cases on the main board could short to their mounting pads. At work we use mylar spacers designed specifically to prevent that problem. However, I was working at home late at night and was impatient. I needed a quick, cheap solution. It came in the form of a 4" nylon cable tie wrap.

I cut off the tapered end so the entire tie was the same thickness. Since the ties are flexible they can easily be snaked down between and under components to act as spacers during soldering. I placed a tie under the crystals and snugged them down tight. Then I soldered the leads. A gentle tug on the tie wrap removed it leaving all the crystals evenly spaced above the board.

SALVAGING PC BOARD PARTS

From: Vic Black, AB6SO

Most surplus dealers sell PC board assemblies cheap. If you find one with RF parts on it, grab it quick. When you get home grab the board with Vise Grip pliers, turn it upside down and heat the circuit (solder or non-component) side with a high wattage hot air gun or a propane torch. When the solder starts to flow give the board a smart tap and the parts will drop off cleanly. Use safety goggles. Be sure to do this outside with adequate ventilation since the epoxy on the board will scorch and give off nasty fumes. Also, do it over old newspapers to catch the parts and all the solder that will drop off the board. Don't worry about harming your parts. The board acts as an insulator between the heat source and the components. The parts won't get any hotter than they did when they were wave soldered to the board.

A Digital Display for the Epiphyte

by Derry Spittle, VE7QK
1241 Mount Crown Road
North Vancouver, BC, Canada V7R1R9
e-mail: jds@freenet.vancouver.bc.ca

The **BASIC COUNTER** (Fig. 1) comes from a 1976 article by Lloyd F. Botwoy in *Electronics*. It is based around the CD4026BE decade counter/7-segment decoder. There are no display latches, no extra logic for generating a count-reset pulse and no current limiting resistors in the display segments. A crystal controlled clock has been substitued for the RC tuned multivibrator used in the original circuit and the necessary logic to program a 453 KHz IF offset has been developed. Although the counter has a LSD of 100Hz I have chosen to "prescale" the input signal with a decade-divider so that the 4 digit display has a resolution of 1 KHz.

The **CLOCK** (Fig. 2) generates 50Hz complementary square waves from a 3.2768MHz crystal oscillator and divider with a modulus of 2^{16}. The circuit in (a) uses a M706BI 50 Hz timebase manufactured by SGS-Thomson. As this is now difficult to find, an alternative circuit using readily available semiconductors is shown in (b). I breadboarded one up to ensure that it worked.

TIMING (fig. 3). Each "cycle is of 20 ms duration (1/50s). Pulses are counted during the first 10ms, the "count period", at the end of which Q goes "high", the counting is terminated and the display is "enabled". At the end of a further 10ms, the "display period", the system is "reset" and the cycle is repeated. The positive reset pulses are generated every 20ms by differentiating the complementary output with C1/R1. D-1 "clamps" the negative pulses.

The **OFFSET LOGIC** assumes the VFO to be 453 KHz higher than the signal frequency. Since the VFO frequency is first reduced by a factor of 10 andthe count period is 10ms, reducing the number of pulses reaching the display counter by 453 (453,000 Hz x 0.1 x0.01s = 453) will allow it to register the signal frequency. At the commencement of each cycle the output of AND gate U-3b (pin 9) is LOW. AND gate U-3c is closed and NOR gate U-2a is open. Once the 4040 binary counter has received 453 pulses pin 9 of gate U-3b goes HIGH, gate U-2a closes, and gate U-3c opens to permit pulses to pass to the 4026 display counters for the balance of the count period.

The components are inexpensive. MOUSER lists 4026s at $0.61, .30" common cathode displays at $1.82 (you cannont use a multiplexed display) and clock crystals at $1.24. With a solderless breadboard you can have lots of fun. There are countless (no pun intended) combinations of gates which will achieve the same result. Experiment and impress everyone with your newly gained knowledge of Boolean algebra and truth tables! No PCBs are available at this time but I'm sure something will be produced if there is sufficient interest. This unit is much quieter than programable counters with multiplexed displays. Any 50Hz leakage is usually well below band noise.

I recently resurrected one from the junk box and installed it along with the Epiphyte in a TenTec 5" x 4" x 2" box. The 2" x 3.25" counter board is mounted in the top half of the enclosure along with the 4-digit display on brackets which place it behind the front panel. Using the "alternative" clock circuit the pcb would be slightly larger.

A word of warning. While the CD4026 is rated for 18V do not be tempted to use other than 5V. The LED displays, without limiting resistors, will draw too much current and it is a toss-up which burns out first! The input amplifier is "crude" but works fine. I have found there to be no advantage in "shaping" the input signal. CMOS logic is very tolerant of sine waves. Enjoy. 72, Derry, VE7QK

FIG. 1 - THE COUNTER

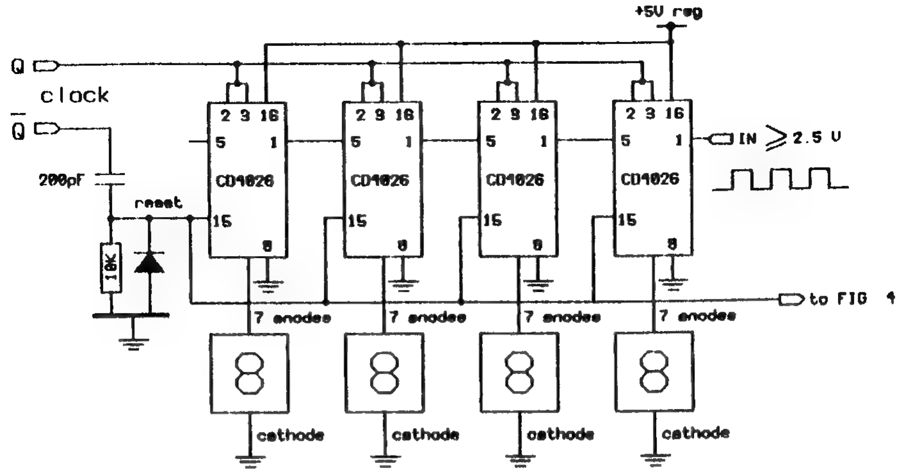
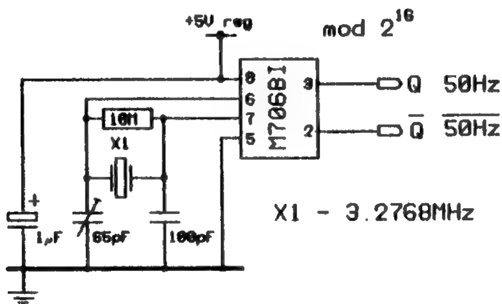


FIG 2 - THE CLOCK

(a) M706BI 50Hz timebase



(b) alternative circuit

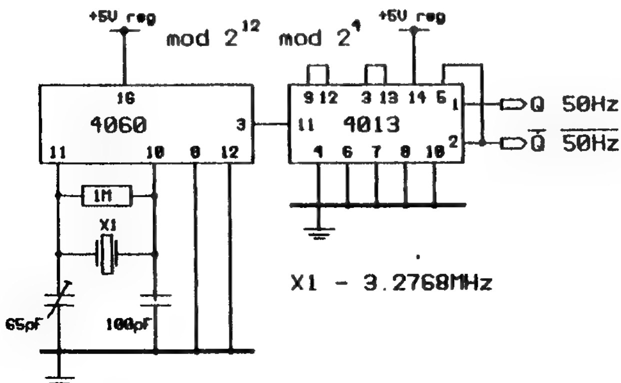


FIG. 3 - TIMING

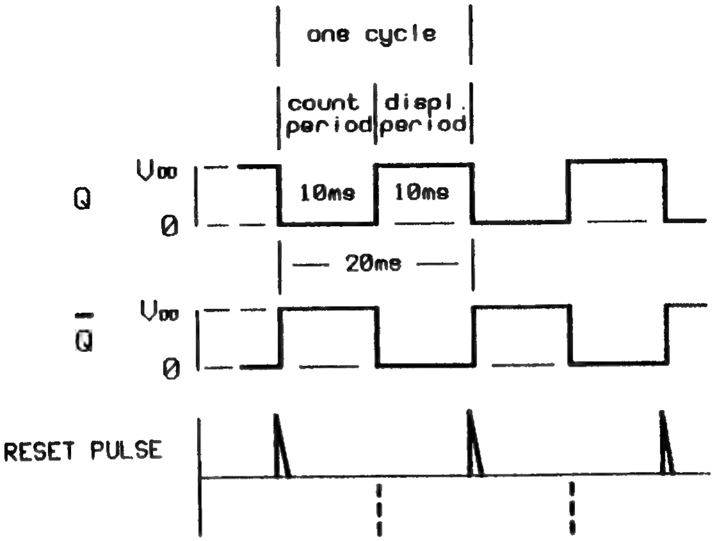
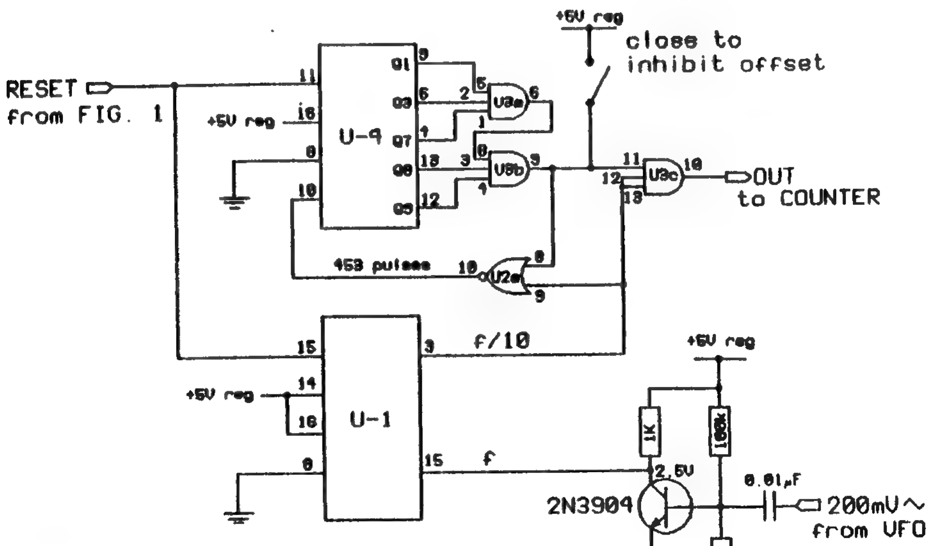


FIG4. - OFFSET LOGIC



U-4 PROGRAMMING									
Q	Q9	Q8	Q7	Q6	Q5	Q4	Q3	Q2	Q1
BINARY 453	1	1	1	0	0	0	1	0	1
PIN (4040)	12	13	4				6		9

U-1 74HC4017E DECADE COUNTER/DIVIDER
U-2 4001BPC quad 2-input NOR gate (3 sections unused)
U-3 4073BPC triple 3-input AND gate
U-4 4040BPC 12-bit BINARY COUNTER

Spring QRP to the FIELD Contest

1600Z to 2400Z Saturday, April 1, 1995

Get ready for June Field Day, by testing equipment on the "Spring QRP to the Field" - **Open** to all radio amateurs, and all bands. Sponsored by the Northern California QRP Club.

Single Transmitter only. Once started, you must use the same power output and location categories.

Exchange: CW - RST & State, Province or Country
SSB - RS & State, Province or Country

QSO Points:	1 Watt or less:	CW = 10 points SSB = 10 points
	5 Watts or less:	CW = 5 points SSB = 5 points
	More than 5 Watts	CW = 2 points SSB = 1 point

Multipliers:
Field location = 3.0 x multiplier (Field = Battery power and tempo rary antennas.
Home Location = 1.0 multiplier (Home = Commercial power or per manent antennas)
Homebrew Equipment = 1.5 multiplier (If you built it, it is homebrew)
Commercial Equipment = 1.0 multiplier

Final Score:
Band/Mode QSO Points x location multipliers x equiment multipliers = Band/Mode Total
Add Band/Mode Totals for final score.
Example:
(15) 20M/SSB QSO's x 5 (5W) x 3 (Field) x 1 (Comm) = 225 points
(35) 40M/CW QSO's x 5 (5W) x 3 (Field) x 1.5 (HB) = 788 points
Final Score = 1013 points

Awards: "Top Ten Scores Certificate. (The ten stations with the highest point totals)
"Participant Certificate" for 20 or more contacts from a field location.

Send logs, station and location description along with a summary sheet and photos to:
Bob Farnworth, WU7F
Spring QRP to the Field Contest Manager
6822 131 Ave. SE
Bellevue, WA 98006

Entries must be received by May 1, 1995. Send a #10 SASE for results. All decisions pertaining to this contest rest with the contest manager, and his decision is final. Please send a summary of your comments about the contest along with your entry.

QRPp, Journal of the NorCal QRP Club
862 Frank Ave.
Dos Palos, CA 93620

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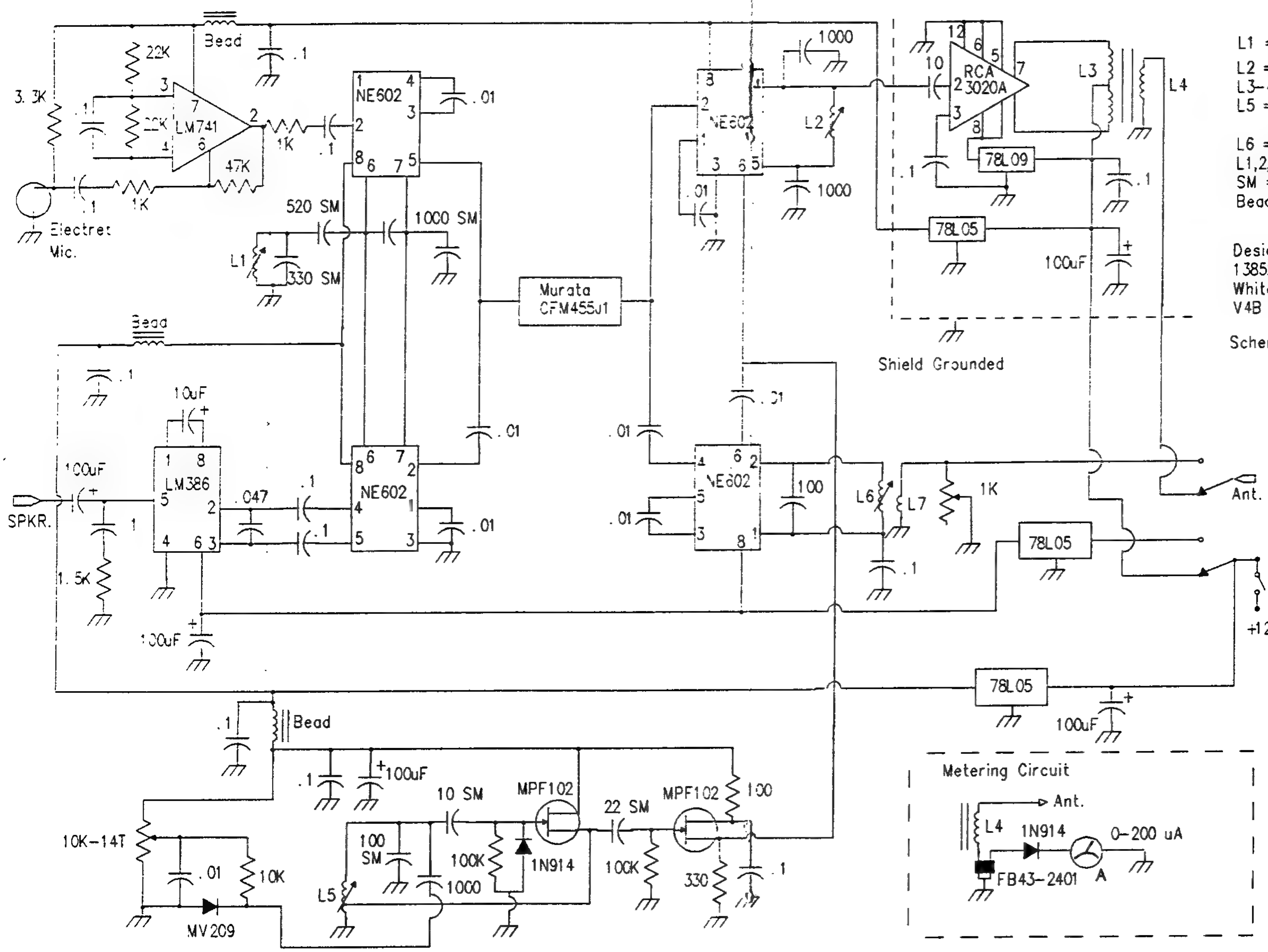
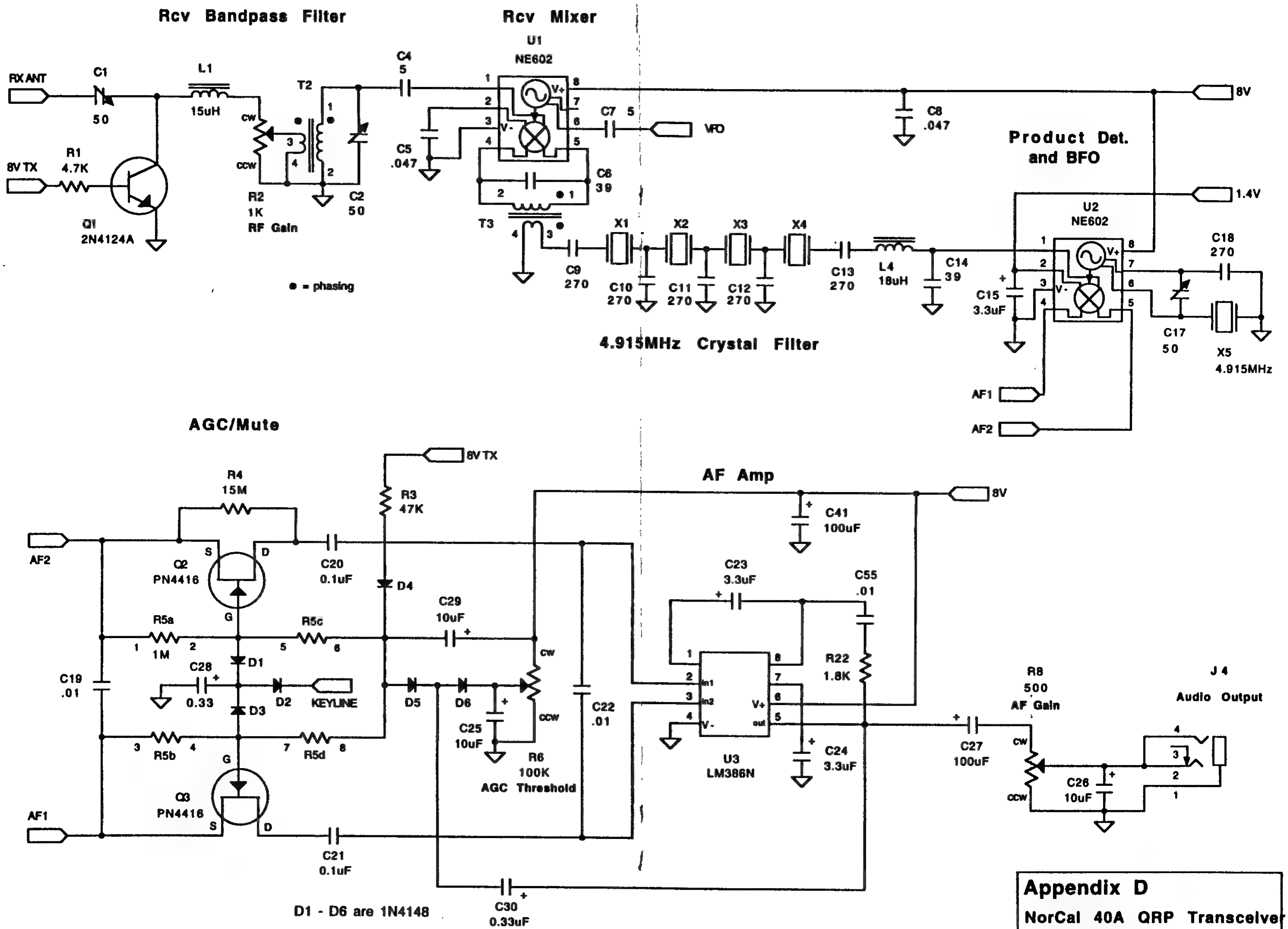
VE7TX NEOMYTE 75M SSB TRANSCEIVER



L1 = 250T #36 on 1/4" Slug Tuned
L2 = 20T ##6 on 1/4" Slug Tuned
L3-4 = 6T #30 Trifilar on FT37-61
L5 = 30T #36 on 1/4" Slug Tuned tapped at 8T
L6 = 30T #36 on 1/4" Slug Tuned
L1,2,5 Are Shielded
SM = Silver Mica
Bead = 2T #36 on ferrite bead

Designed by Joe Stivec, VE7TX
13852 Marine Dr.
White Rock, BC
V4B 1A4

Schematic Drawn by KI6DS

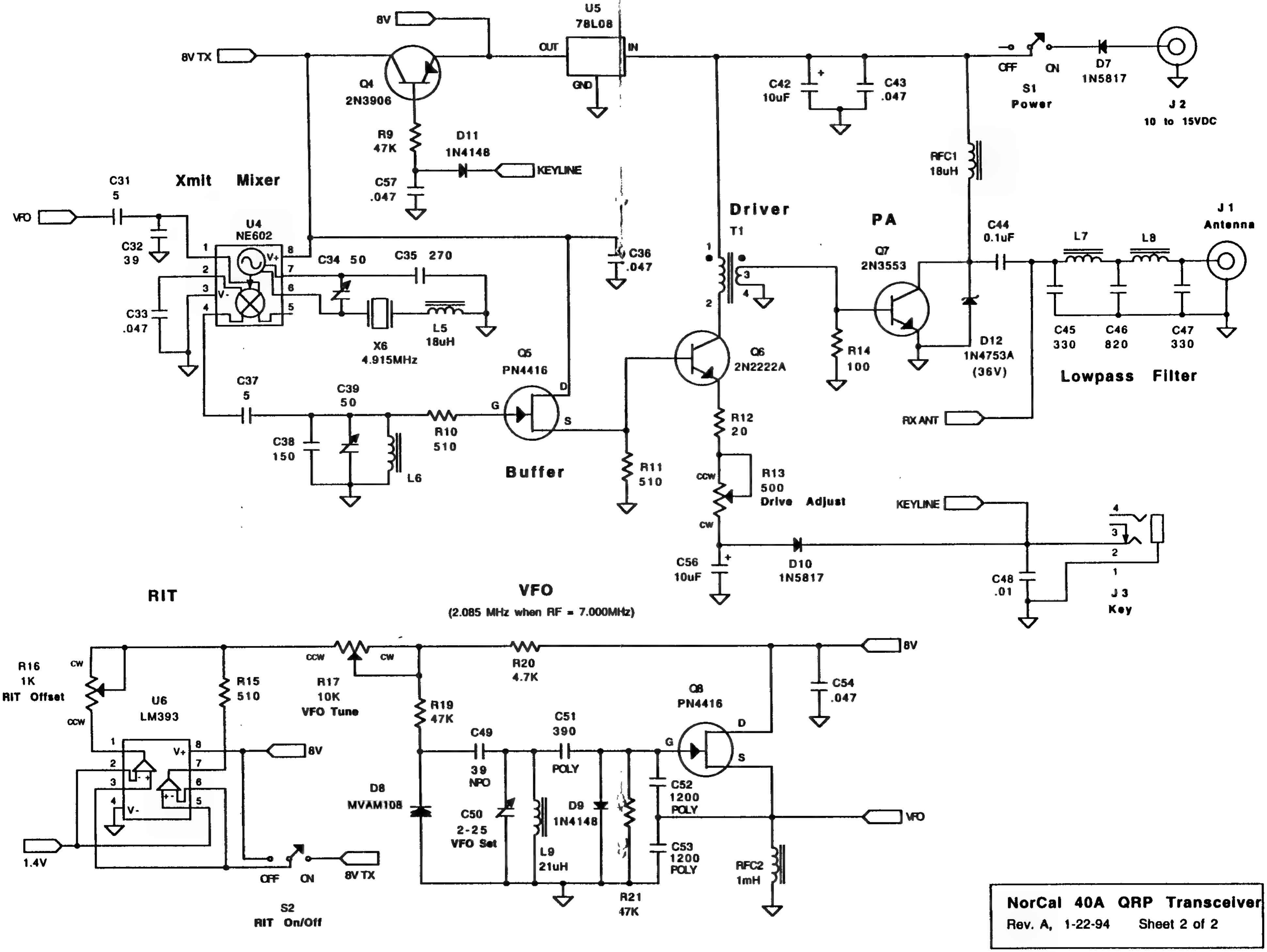


Appendix D

NorCal 40A QRP Transceiver

Wayne Burdick, N6KR

Rev. A, 1-22-94 Sheet 1 of 2



NorCal 40A QRP Transceiver
Rev. A, 1-22-94 Sheet 2 of 2

W1HUE

QRPp

Journal of the Northern California QRP Club
Volume III, Number 2, June 1995

From the Editor

by Doug Hendricks, KI6DS
862 Frank Ave.
Dos Palos, CA 93620
dh@deneb.csustan.edu

The first thing that you will notice is that QRPp is a little bit different. Do you like the color scheme of the covers? That happened quite by accident. When I took the last issue to the printer, they did not have any of the yellow cover stock, so I chose green. I noticed that it was really easy to find my March issue, so I decided to have a "color" scheme for the various issues. March will be green for spring, June red for summer, September yellow for fall, and December blue for winter. Also, you will notice the quality of the printing is better. That is because QRPp is now being printed on a web press. Don't ask me to explain it, because I can't, but it is cheaper and better quality than Xerox once you get over 1000 copies. Note that we are now able to do photographs. Turn to the article on the Mr. Baldy Expedition, and you will see 2 pages of great pictures. Many of you have requested pictures, and now we have the capability. When you write those great articles, plan on sending along some pictures. Just make sure they are clear and have lots of contrast.

The next order of business is what is coming down the road. NorCal has a couple of projects that are in the pipeline. The Cascade was introduced at Dayton, and we mailed a brochure describing it to every member. It is the dual dual band ssb rig designed by John Liebenrood, K7RO. The transceiver puts out 8 watts on 75 and 5 watts on 20, or you can put a version on 40 and 17 meters. It is really exciting to operate QRP SSB, and I love my Cascade. The Icom 735 has been gathering dust since I got the Cascade built. The other project that we are gearing up for is the St. Louis Tuner. The St. Louis Tuner is a QRP tuner based on the Stocton Watt Meter and was developed by the St. Louis QRP group. We have made arrangements to offer it as a kit, and it will come in two flavors, in a NorCal 40 sized case, or in a Sierra sized case. It is a great tuner, and we will have more details in the next issue.

There are lots of good articles in this issue, and there are a couple of rigs that are for the beginner. We had kind of forgotten the beginners out there, so I made a special effort to find a couple of "beginner" type projects. Check out the Pixie 2 and the Key-7. Both of these rigs are offered as kits, and they are perfect for those of you who want to build your own boards. The Pixie 2 was the circuit that we used for the NorCal Build it at Dayton Contest. It was a lot of fun.

QRP to the Field was held the 1st of April, and we will have a full report in the next issue. I operated with Vern Wright, W6MMA, from his backyard in the foothills of the Sierras. We used the Epiphyte and the Cascade, and had a blast. It helps to have a 55 foot portable tower and a 5 element beam on 20 meters too!

Bob Finch, one of our members has come up with a great looking membership certificate. Details for that will also be in the next issue.

Finally, I have retired as Basketball Coach at Dos Palos High School. That should give me more time to devote to my favorite past time, QRP. I was amazed at how much time that I had this spring. I got to build a Cascade, work on a Pixie 2, go to Dayton, take my wife out for a couple of weekends, relax and have fun.

I have been working a nightly sked with several of the guys in Canada, and they have some more projects that they are working on. My rig has been QRP every night for the past month, and I have made it every single time! Who says you can't work with QRP! Hope that you have a great summer, and I will listen for you on the air. 72, Doug, KI6DS

Simple 160 Meter Antenna in a Restricted Space

by Stephen Modena, AB4EL
2729 Oberlin Road
Raleigh, NC 27608
Internet: ab4el@cybernetics.net

Most people don't think of 160 meters as a QRP band, but this really is a "qrp" article. Here is why: since the antenna is full-dimensioned, it must approach and intrude upon my neighbors. On 20 M and above, 100 watts to my vertical wire antennas definitely bother at least one of my neighbors. At five watts I have no problem. At 100 watts, my ground- mounted 80 M ground plane doesn't seem to bother anyone...maybe because of frequency, maybe because it is just far enough away from them. For the 160 M case, I must come close to the neighbors and I intend to keep my power down.

I live in a single-level duplex: my half of the "lot" is 90' x 60'. Of course, my side of the duplex occupies more than one-quarter of it. Fortunately, I have a cluster of fine tall pine trees...a factor in choosing to rent this particular apartment. Tall pine trees are fine for hanging vertical anetnnas. I have four wire antennas: all are "city verticals."

I like to experiment with antennas...and my living situation is such that I must experiment. A few years back, I picked up a 5,000 ft roll of #22 stranded, insulated wire for $5. Cheap wire in hand, I never hesitate to reel off whatever wire I need to try out antenna ideas. The wire is throw-away...no second thoughts.

Past reading of NEC modelling of a ground mounted ground-plane antenna indicated that for *short* radial lengths, five insulated above-ground radials were no less efficient than a large number of radials. Peak radiative efficiency occurred in the vicinity of 1/8 wavelength radials—then fell at greater lengths if the number of radial was five, or twenty. If there are 120 radials, efficiency continues to rise as the length of the radials increases. This does not mean that short radials are efficient relative to a horizontal dipole 1/2-wavelength
above ground. It does mean that under the contraint of *short* radials, 120, 20 and 5 radial-antennas are comparable. Understanding this breaks past a psychological barrier that might inhibit one from even trying!

Since I already have a 80 M antenna of the intended type, I know that a 66 foot vertical wire, looped over at the top giving an apparent resonance around 3.8 MHz in conjunction with six radials of 32 ft. Therefore, I began by reeling off 132 feet of the #22 for the vertical portion and four pieces of 66 feet for the radials.

I lanyarded the 132' wire up the tree, over the top and down again. I attached one end of the wire to a line which I shot over the limb of a close-by pine and hauled it up. This gave me an approximately 75 foot vertical portion with the remaining ~60 feet bent over and gently, crookedly sloping downward about 40 feet in a South-SouthWestly direction.

Why four radials? Because of physical restraints. The pine with the vertical wire is on the property line (east-west). I stretched one wire west and staked it at the edge of the back access road. I stretched another wire eastward, covering it with pine straw and burying it where it runs near and under the back entrance path of my neighbor in the other half of the duplex, crooked it, ran it around the edge of the house foundation. We both rent...and mylandlady likes me. The third radial runs slightly east of south on top of the pine straw, into the crawl space of the apartment and is staked against the far foundation wall. The fourth radial runs more-or-less SouthWest, hops a low curbing at the corner of the house and is staked finally in what passes for my day lily flower bed. I can not run radials northward at all.

This is not a balanced radial net relative to the vertical element...but the fact that that vertical element "leans" over to form a "hat" over the radial field may help things.

I soldered the vertical wire to the center receptical of a female coax fitting. I pigtailled the four radials together and soldered them to the "plate" of the coax fitting. I tethered the coax fitting two feet above ground and one foot from the trunk of the pine tree.

Using my MFJ Antenna Analyzer, I found the SWR was still dropping as I tuned below 1.8 MHz. I removed some wire from vertical wire... until the SWR "dipped" at 1.860 MHz (1:1.2+ was lowest value, which is a combination of radiation resistance plus ground losses). Based on past experience, this is the result I expected.

I soldered coax plugs onto a spare 57 ft piece of RG-59 (75 ohm) coax...and re-checked SWR curve. It was never below 1:2 and the "dip" was out-of-band.

I inserted my old, cheapy MFJ transmatch between the coax and the Antenna Analyser. Setting the Analyser to 1.850 MHz, I tuned for lowest SWR (are you following this?). Because this is 160 M, the tap position is the last one...putting the whole inductor into the circuit. It's not quite the right value...resulting in not getting a match lower than 1:1.6 anywhere in the 160 M band.

Then I insert Transmatch *between* antenna feedpoint and coax feed line. The Antenna Analyser was still positioned at end of coax, where the transmitter would be *without* the transmatch (Are you following this?). Setting the Analyser to 1.850 MHz, I adjusted the transmatch: the SWR drops to 1:1...giving a 1:1.2 SWR-bandwidth of over 20 KHz.

Detaching the Analyser, I stretched the coax to my car 40 feet away. I hooked it to my cross-needles SWR meter which in turn is hooked to my Kenwood TS-430-S (remember, the transmatch is *at* the antenna feed point, not at the transmitter!). Sweeping band at low power, it appeared I've got at least 30 KHz bandwidth of operation before I'd need to readjust the transmatch at the antenna.

That describes my main antenna used for the QRP SSB Fox Hunt on Tuesday, 28 Feb. Though I used this city-lot antenna for the Hunt, I could have used my mobile antenna—a loaded 18-ft mast on my 1979 Ford LTD. I asked several stations to give me a comparison reading between them as I switched back and forth. The mobile mast was one or two S-units weaker...but copyable to all, even the Michigan QRO station that called me.

160 M is worth a QRP effort. Night time skip appears to be excellent. Don't hinder yourself by thinking that you must litterally own a couple of acres to put up an antenna for this band. Nothing could be farther from the truth. 73/Steve/AB4EL ab4el@Cybernetics.NET in Raleigh, NC 35.81245N, 78.65849W

Advice to a Beginner

by Cameron Bailey, KT3A
POB 173
Mount Wolf, PA 17347
BAILEY%IS%211EIS@PAMDT.ANG.AF.MIL

Glad to meet you. I remember back in 79 when I was 23 years old. I had no money for ham gear. The license was free though. All I had to do was study (ARRL Handbook 76) and practice code (on borrowed tapes). I had my Extra in less than 2 years after 4 trips to the FCC in Baltimore. I figured the money would be there later. Then I would buy a rig.

There are a lot of good kits out there. Get one that comes in pc board form less pots, case, knobs, etc. You can save a bundle by scrounging around for those parts.

Do you have a balcony or metal rail? Clamp on a Hamstick. They sell for about 18 bucks and work. I use one on the roof (metal) of my mobile home. We are not allowed antennas there either. I find that challenging too.

My elmer loaned me a Gonset communicator II (2 meter AM). I converted it to FM transmit and used slope detection for receive. I had to buy a $10 crystal. Made my first contact on the local repeater with it!

I had a Heathkit HT for 2m. My first HT. It was a piece of trash. But, I eventually got decent rigs for HF and VHF. Took about 10 years. My point is that I now get more satisfaction out of doing more with less. Whether that be in terms of power or money, it does not matter. If I built it, then I enjoy it even more. My goal is not to have all the best commercial equipment. It is to have built everything I use. This is even going to include VHF SSB gear. (QRP of course). HF is the best place to start. Build a DC or superhet receiver or a crystal transmitter. Try going portable. Find a school yard with trees and throw up a dipole. The point is to get some experience, it is the best teacher by far.

One thing about the QRP hams....they are some of the best encouragers I've met. We'll all cheer you on. 72 de Cameron, KT3A

QRP ARCI Awards Summary

by Chuck Adams, K5FO

Internet: chuck@sgi.com

1,000 Mile/Watt Summaries by Band

BAND	TOTAL	GREATEST VALUE	CALL
1.8 MHz	10	13,300 Mi/Watt	GW4AEC
3.5 MHz	42	851,339 Mi/Watt	AA2U
7.0 MHz	195	1,909,502 Mi/Watt	AA4XX
10.1 MHz	15	20,727 Mi/Watt	NW0O
14.0 MHz	380	87,800,000 Mi/Watt	OK1DKW
18.0 MHz	3	59,380 Mi/Watt	K4TWJ
21.0 MHz	445	19,250,000 Mi/Watt	WB6UNH
24.0 MHz	4	2,445 Mi/Watt	JL1FXW
28.0 MHz	207	218,333,333 Mi/Watt	K7IRK
50.0 MHz	56	134,200,000 Mi/Watt	JO1XWH
144 MHz	13	87,800,000 Mi/Watt	OK1DKW
220 MHz	2		
432 MHz	5		
1296 MHz	6		
10 GHz	2		

CW 1043
SSB 296
AM 47
FM 7
RTTY 4

other 15 (some unknown)	
WAC	526 awards total
DXCC	124 awards total
WAS	352 awards total
QRP-25	1041 awards
QRP-50	559 awards
QRP-100	342 awards
QRP-200	121 awards
QRP-300	52 awards
QRP-400	26 awards
QRP-500	18 awards
QRP-600	11 awards
QRP-700	8 awards
QRP-800	4 awards
QRP-900	2 awards
QRP-1000	2 awards
QRP-1100	1 award

NOTE: N5DUQ gets the first 5-Band WAS SSB QRP ever. 72, Chuck Adams, K5FO, ARCI Awards Manager

Atomic Bomb Anniversary Special Event Station

by Paul Harden, NA5N
120 Garden Cir.
Socorro, NM 87801
pharden@aoc.nrao.edu

The local (Socorro, NM) ham club received official permission Tuesday from White Sands Proving Grounds for us to operate a special event station from "ground zero" at the Trinity Site on the 50th anniversary of the first atomic detonation. They imposed a fairly narrow window on us for operating, namely 0500-noon local time on Sunday, July 16, 1995. Therefore, in addition to the QRO stuff, we will try to keep two QRP stations on the air to makeup for this short window. Also, we will be operating the day before as well, Saturday and later that Sunday afternoon, from somewhere.

We're trying to get permission to work out of one of the old barracks buildings used during the test, now located on private land. Details of the Saturday and Sunday afternoon/evening operation will be issued later. However, the Sunday operation is officialized, and I'm including the official "politically correct" White Sands approved press release. This is the version to appear in QST, etc. (We are verbotten from using the word "celebration.")

By the way, you'll notice whose call they voted on to use at last nights ham meeting. And I wasn't even there!
—Paul NA5N

White Sands Press release:

Amateur Radio Operators Will Observe the Fiftieth Anniversary of First Atomic Bomb Test

The 50th anniversary of the world's first atomic bomb test will be marked by an amateur radio special event station operating from near Ground Zero — Trinity Site — in

the Central New Mexico desert.

The Socorro Amateur Radio Association (SARA) will operate NA5N from 1100-1700 UTC on Sunday, 16 July 1995, and will use the General phone and CW portions of the 80, 40, 20, 15 and 10-meter bands, depending on propagation. On the CW bands, a war-veteran straight key from the Pacific Theater of World War II will return to the air for this event.

Just before dawn on 16 July 1945, the Manhattan Project successfully tested the first atomic bomb at Trinity Site, about 36 miles southeast of Socorro, New Mexico. Trinity Site, now a part of the U.S. Army's White Sands Missile Range, normally is opened to the public only twice a year, in April and October. The Army is opening the site for visitors on the morning of 16 July for the 50th anniversary, and has granted permission for SARA to operate the special event station then.

The station will operate only during the six-hour period 1100-1700 UTC. Because of missile range requirements, the transceivers at Trinity Site will be limited to 50 watts output power. In addition, a QRP station will be operating on the QRP frequencies of 7.040, 14.060, 21.060 and 28.060 MHz, again depending on propagation.

For a QSL/Certificate, amateurs contacting the Trinity Site Special Event Station should send QSL and business-sized, self-addressed, stamped envelope to the Socorro Amateur Radio Association, Trinity Site Event, P.O. Box 522, Socorro, NM 87801.

Trinity Site will be open to the public the morning of 16 July. The White Sands Missile Range Stallion Gate will be open to visitors from 5 a.m. to 11 a.m., MDT. Stallion Gate, east of San Antonio, NM, (on US 380) will be the only gate open to the public for this event. On 15 July, the National Radio Astronomy Observatory will offer guided tours of the Very Large Array radio telescope west of Socorro. For information about accommodations and other events in the area, contact the Socorro County Chamber of Commerce, P.O. Box 743, Socorro, NM, or call (505) 835-0424.

Replicating the Epiphyte: Reproduction with Compromise

by Grant Hannan, VE7PTW
1725A Boundary Avenue
Nanaimo, BC Canada V9S 4P3

The pleasures that make amateur radio such a fulfilling endeavor are not the same for every amateur licensee. For one it may be the thrill of chasing a rare DX station. For another it may be the coordination of a local traffic net. And yet, for someone else it may be blasting out the strongest signal on any band. The satisfactions of ham radio are as varied as the hobby itself.

My earliest recollection of the thrill of radio was way back in the late fifties when my soon to be brother-in-law brought a crystal detector in the package of a rocket to our home. This Rocket Radio captured my attention as the sound of a distant AM broadcast station filled the tiny earphone. How could something so small offer such pleasing results?

Several years later I once again discovered the excitement of using less to accomplish more when my high school electronics class built one-tube transmitters and thereby pounded out CW to an unsuspecting world. Does anyone recall the venerable 6L6?

The summer of 1994 brought our family to beautiful British columbia from the prairie land of Saskatchewan. Any previous exposure to QRP in VE5 land was, of course, in the form of morse code. By late summer I had learned, though, that an active group of West Coast hams enthusiastically pursued the design and construction of single sideband

QRP transceivers. Subsequently, an invitation was made to attend a meeting of this illustrious body to be held right here in Nanaimo in September.

It was at this meeting that I first was made aware of the Epiphyte and the other SSB transceivers conceived and born in BC. It was also the first time that I was able to meet those who now have become household names to me. VE7QK exhibited a completed circuit board for the Epiphyte. The careful attention to layout and ease of construction could not go unnoticed. Although I had not yet heard the Epiphyte, the decision was made to try to replicate one of those little radios.

As was suggested by Derry, VE7QK, the circuit board was ordered from FAR Circuits of Illinois. By this time two more local hams had decided to build the Epiphyte. Various delays resulted in the boards arriving in mid-November. Availability was not the problem. Apparently the postal system may have caused the delay.

Once the boards were received, many of the components were purchased locally and on the lower Mainland. A couple of evenings labor resulted in most of the parts being soldered to the board. The article submitted by Derry which appeared in the September 1994 issue of QRPp "The Epiphyte, A Simple SSB Transceiver" pp. 29-37, was invaluable to the construction of the circuit board. By closely following the schematic and the parts layout, all components fit neatly in their respective places. Enlarging a photocopy of the top side of the board also helped to determine what went where. The traces on the bottom side of the board are readily copied through the board material. This provided a top of board view with all the traces clearly visible.

Most amateur radio enthusiasts could work wonders if only they had the time to devote to their passion. However, distractions do occur which divert one's attention from the task. For me, the Epiphyte project had to be put on hold for a time while I dealt with the consequences of a break and enter at my home QTH near the end of November. Among the items stolen was my Standard Twin Band handheld. The replacement unit which arrived inJanuary played a vital role in putting the Epiphyte on the air.

Along with the theft of many of our prized possessions came another period of time where the Epiphyte had to be put aside to await another day. By now it was December and the holiday season was upon us.

The last few remaining parts to obtain were the ceramic resonators, the Murata filter, and the Toko coils. Working together with Rod, VE7ESA, the 4.19 MHz resonators arrived from a supplier in the UK. A short time later the remainder of the needed components arrived via parcel post. These were hastily soldered into place. The chassis and case had been prepared ahead of time, making use of the time while waiting for parts to arrive.

Tune up and alignment were accomplished in compliance with VE7QK's article. The exception was that I used my Standard handheld's capability to produce a single frequency tone of 1209 hertz. Duplicating this tone by that produced from the crystal calibrator of my Yaesu HF rig gave me a constant, QRM free audio tone which was injected directly to the self-contained electret microphone. The end product was an easy alignment of the the RF filters and output consistent with predicted results. The project was complete, or almost.

The Epiphyte succeeded in surpassing all expectations. Reports while operating barefoot were pleasing, if not flattering. I was able to check into the British Columbia Public Service Net on 3729 kHz. with no comment made as to the little rig sounding good or bad. As far as I am concerned this speaks volumes for this radio. But a little extra punch would be desirable and the decision to add a 5 watt amplifier was made.

The circuit board for the amplifier was locally produced by Harry, VE7BUY. Harry is also constructing an Epiphyte. He should be on the air by the time this issue is pub-

lished. [Note: He is, as I made contact with him on the VE7 SSB QRP net on March 27, 1995. KI6DS, Editor]. The circuit board and the components went together in one evening. In my case I decided to run the amplifier outboard to allow for flexibility in future usage. An external dynamic microphone was the final additon to this date, although a frequency display is not too far off. On air reports with our friends of the NorCal group and with many VE hams, both local and distant, have been better than complimentary. The Epiphyte performs like a big rig; better, if one considers the invested cost per qso.

VE7QK's article states that one of the objectives in designing the Epiphyte was to produce a transceiver that was easy to replicate. That objective has been met with certainty. Furthermore, Derry noted that a radio of this simplicity cannot be achieved without compromise. Obviously this is true, but building the Epiphyte does not mean one needs to compromise performance. On the contrary, the Epiphyte offers ease of reproduction in a way that just may redefine compromise. If one follows recognized assembly procedures, the "plant growing on another", will yield "**COM**munication **PROMISE**". If all the parts were on hand when the project began, this transceiver could have been on the air in less than one week, start to finish. Even though this Epiphyte took more time, the degree of satisfaction has not been diminished.

I would be remiss if I did not extend my thanks to Derry, VE7QK, for his efforts surrounding the Epiphyte. Also to the members of the QRP Club of BC for their many reports on signal quality and strength. And those of the NorCal group who are more than willing to encourage all others who wish to experience the pleasure, the thrill, and the excitement of **QRP: DOING MORE WITH LESS TO REPRODUCE THE PROMISE!**

72, Grant, VE7PTW

Requiem for a Fox Hunt

by Glen E. Stockton, K5UP
4736 Baylor Dr.
Bartlesville, OK
Internet: ges@ppco.com

Just a note on the late, great first-ever qrp hf cw fox hunt. I've been asked what kind of antenna, etc., I used while pursuing Mr. Fox. The answer is ... nothing spectacular. All contacts were made with an HW-8 (1 watt on my homebrew meter) for a transmitter and most were made with a Yaesu FRG-100 for a receiver. Antenna is a dipole up about 25 ft situated north-south. That's it - but in the works are a transmatch/G5RV and a dsp filter (and, oh yeah, a xcvr from Small Wonder). I guess that I'm already thinking about the next foxhunt!!!

I don't know how to properly thank Chuck , K5FO, for the concept, prizes, etc., nor the foxes for their sometimes heroic efforts at digging weak ones out of the noise, so I'll just leave it at that. Thank you.

The foxhunt was interesting, entertaining, rewarding, educational, and at times frustrating, and at other times, very frustrating - but it was alway fun. However, unlike some other contests, the foxhunt wasn't without a purpose - it got some of us to dust off our keys and do a little qrp operating. I think it fulfilled its purpose very well.

73s, Glen K5UP

Maryland Radio Center QRP Show and Tell

by Mike Czuhajewski, WA8MCQ
7945 Citadel Drive
Severn, MD 21144
Internet: wa8mcq@hambbs.wb3ffv.ampr.org

Another good QRP Show and Tell at Maryland Radio Center in Laurel, MD! We had our usual 2 dozen-plus people, lots of familiar faces and calls, some new ones seen in person for the first time, some merely-curious non-QRPers, etc.

K3TKS, Danny	KD3S, Jim	N3GZT, Mark	WA2UNN, Clark
N3LRX, Randy	KC3MX, Harry	N3MIT, Pat	NF3I, Scott
W6TOY, Bruce	WA5JAY, Hal	N3CDR, Herb	KD3IO, Bob
K2EB, Bob	KO4A, John	N3AFN, Walt	KT3A, Cameron
N3JBU, Ken	WA4DWD, Bob	WA8MCQ, Mike	WA4KAC, Walt
KA3ZOW, Dick	AF4K, Brian	WO3B, Bob	WB3V, Bill
W4NFR, Bill	K3OAH, Allen		

K3TKS brought along his QRP Plus to show off and ran coax to the MRC antenna patch panel so we could check it out properly. Neat rig! W4NFR also brought one along; he's a salesman for the QRP Plus, showing it off at hamfests and taking orders for Index Labs. K3TKS also brought along his usual collection of Kent keys and paddles.

WA5JAY showed off his tiny 40M CW XCVR-in-a-pill-bottle, one of the DB-25 series of rigs, and I had both WG3R's 40M CW XCVR-in-a-pill-bottle as well as my own transmitter; this is the first time in several years that there have been more than two DB-25 rigs in the same room at once. I also showed off the package to be used for Phase II of the DB-25 challenge (see the March 95 issue of QRPp); no one has done any soldering yet, but at least I have an SMA jack mounted on the fuse box, earning me the honor of First Blood.

WA5JAY also showed off his 3 X 3 X 3/4 20M SSB XCVR, built circa 1990. KT3A brought a NorCal Sierra, the first one I've seen in the flesh, and it was impressive! KA3ZOW, of S&S Engineering, had his new TAC-1 knob-tuned synthesized rig, and says he expects to ship very soon—the cabinets should be in this week and that's all he's waiting on. There were also various NorCal 40/40As, NE3040/4040s, etc. Not as many QRP rigs as we usually have, but still a good variety and lots of good QRP stories being slung around right and left.

We'll probably do one of these again in a few months; stay tuned for the announcement! 73 and Queue Our Pea DE WA8MCQ

A Unique Way to Install the MRF237 in the NC40A

by Stephen Shearer, WB3LGC
10 Brackin Ave.
Wilmington, DE 19805
Internet: shearer@eplram.dnet.dupont.com

I knew there was a reason I havn't rushed to get my NC40A up and running with modifications from the past QRPp journals (I do need to find space in the shack to work, first).

I am planning to add a MRF237 to my rig (as I build it) and want to pass on my comments/thoughts for doing the modification, as I have not heard of anyone else doing it the way I plan (I never did like to follow the crowd). Since the MRF237 has a reversed

C/E lead compared to the 2N3553, longer leads and insulation/shrink tubing is needed to mount on "normal" side of the circuit board (or emitter path through a grounded heatsink and questionable inductance).

My plan is to use the 0.375" space under the circuit board for mounting a heatsink (customized) to the bottom case for good heat transfer of all the POWER. The MRF237 is 0.180" high and with 0.030 to 0.060 space between the transistor and the board (I plan on a teflon(tm) spacer, as I think I can find a few scraps here at work) — leaving ~ 0.125" free space. The heat sink is going to be a 0.5" round brass with a 5/16" hole in the middle. One end I will drill/tap two (4-40) mounting holes. The other end, I will turn down to ~7/16" and saw slots for the fingers to grab the transistor. Mount the heatsink to the lower case (careful measurments required - use the standoff hole as a reference), install the transistor in the heatsink with leads in alignment to the holes in the circuit board.
NOTE TO BEST PART: the C/E leads are now going into the correct hole, WITHOUT crossing and without a grounded heatsink/emitter lead path. A standard heatsink, like the one supplied, may work just fine — with limited air flow, I want the case to be part of the heatsink. 72/73, Steve WB3LGC

NorCal 40A Measurements

by Robert Neece, N4JEO
110 Sleepy Hollow Lane
Yorktown, VA 23692
Internet: Robert_Neece@qmgate.larc.nasa.gov

My 40a was completed about 10 days ago, and a birth announcement was sent to qrp-l. In that note, I mentioned that the output was trash for low power settings. Last week I had a few minutes to look at the rig on the spectrum analyzer. It was stable and clean into 50 ohms, and there was no indication of instability that I could recognize. The instability occurs when the rig is terminated by my antenna/tuner. Output is fine from maximum power down to 1 W and then it is garbage down to 0.25 W. The results of my lab measurements follow.

NorCal 40a Spectrum Analyzer Test Results from 3/2/95

First test: look at output for recommended supply voltage with power set at maximum

I rcv = 0.02 A　　Vcc = 13.0 V　　I tx = 0.31 A　　Freq. = 7.042 MHz

F (MHz)	P (dBm)	P (W)	Delta (dB)
7.042	34.5	2.82	0.0
14.084	- 3.2	4.79E-04	37.7
21.126	-30.0	1.00E-06	64.5
2.790	-13.5	4.47E-05	48.0

Notes:
The rig was cold for this test. After converting dBm to Watts, the power looks suspiciously high - a goof? The last entry in this table was the first sideband of what looked like a DSB-suppressed carrier spectrum. Probably a mixer product. (Only the highest peak was measured.)

Second Test: a look at harmonic energy as power is reduced

Setting (%)	F P (dBm)	2F P (dBm)	Delta (dB)
100	32.4	-1.4	33.8
90	33.7	-2.5	36.2
80	32.2	-8.5	40.7
60	27.8	-9.5	37.3
40	-3.0	-35.0	32.0
20	-29.0	noise	noise
0	-32.0	noise	noise

Note:The "setting" is for the power control Potentiometer.

Third Test: a look at harmonic energy as frequency is varied.
Power output was set for the cleanest output near maximum power out. Power = 2.2 W

Freq. Setting (%)	(~MHz)	F P (dBm)	2F P (dBm)	Delta (dB)
0	7.02	33.5	-3.9	37.4
30	7.03	33.7	-3.9	37.6
50	7.04	33.5	-3.7	37.2
70	7.04	33.5	-3.5	37.0
100	7.04	33.5	-3.8	37.3

Fourth Test: look at effects of changing Vcc a bit

Vcc (Vdc)	F (MHz)	F P (dBm)	2F P (dBm)	Delta (dB)
12.0	7.04	33.1	-3.9	37.0
13.0	7.04	33.5	-3.7	37.2
13.8	7.04	34.1	-3.5	37.6

Note:
Output was set below the maximum at a point where the harmonic was down.

Observations:
The recommended setting for the power pot (90%) is good, since power actually peaks near this setting and is cleaner than for 100%. I noted that the ouput was cleaner just below the peak power output setting. 72, Robert Neece, N4JEO

NW80/20 Review

by Preston Douglas, WJ2V
216 Harbor View N.
Lawrence, NY 11559
PDouglas12@aol.com

MFR: Dan's Small Parts and Kits
ADR: 1935 So. 3rd West No. 1, Missoula, MT. 59801
TEL: 406-543-2872

DESIGNER: Roy Gregson W6EMT 13848 SE 10th St., Bellevue, Wa 98005
MODEL: NW80/20 (Northwest 40m tested)
SIZE: 3" x 5 1/4" x 5 7/8" Radio Shack #270-253A (included, but not drilled/punched/or labelled)
WEIGHT: Heavy, guessed at 3lbs, partly due to heavy gauge steel of cabinet top making package very sturdy.
PC BOARD: Single sided, Silk Screened, perfect fit in above cabinet
MANUAL: 22 Pages, quite excellent with few errors. Construction is step-by-step with modular circuit assembly of subcircuits, tested in stages, giving the builder a great sense of confidence in the probability of success at completion.
POWER: 12-13.6VDC
RX Current: 46 ma @ 13.6; 43ma @12v
TX Current: 1.1A @ 13.6 for 5w; 950 ma @12v for 3.5w (will put out 5w at 12v, but would then exceed 5w at 13.6)
MODE: CW
KIT: Yes. Complete—builder will likely want to throw out RCA chassis mount jacks in favor of 1/4" and 1/8" jacks and the crummy DPDT slide switch for AF filter will routinely be junked for a toggle by most builders. That switch is unworthy of the rest of the kit.
BANDS: Monobanders available on any single band: 80, 40, 30, 20.
VFO: 2.8-3mHz. Reduction cap with nice brass dial collar with clear plastic/red line pointer. Builder makes dial lines/markings on face of cabinet. (Try white contact paper with rub off lines and numbers, covered with clear contact paper—neat, good looking and no spraying.)
DRIFT: Not measured, and none noticed.
RX: Superhet, discrete VFO->602->xtal fil->1350->602->386->AF filter
TX: 5w++ (will go to 7-8w at least, if you want it) board mounted pot for 0-5+watts with builder supplied panel mounted power control pot option.
FILTERS: 4 pole xtal and switched AF
SELECTIVITY: not measured. Estimate 1000 Hz. or 400 Hz. w/ AF fil on.
RIT: Yes
GAIN: AF only
AGC: No
PREAMP: No
ATTENUATOR: No
SPEAKER: Drives a 5" easily and LOUD (Builder supplies the speaker).
METER: Yes, but...this is a relative power meter only, no sig meter (no AGC, so no sig voltage availble) and hardly worth the effort to cut the cabinet to fit the meter. Meter wasused for construction testing, and was useful there.
Notes: I am the kind of consumer sellers must dread. First, I have no hesitation corresponding, writing, and complaining, and I generally make a pain in the ass of myself with kit makers. My NW 40 worked off the bat, but I didn't like the very loud thump on changeover to receive. I worked with Roy, W6EMT, the designer who couldn't have been nicer or more concerned, and he eventually created a gimmick cap to cure my unusual problem. (Created by my ignoring cabinet templates and putting controls in such positions that inductive loops were created.) I paid Dan's the $3.00 he asked for a look-see copy of the manual (refundable against an order), and the manual sold me. One part I liked was that the manual includes Roy's address for kit problems. (Cost: $25 ppd which seems very fair to me.) Every kit builders nightmare is a dead radio at the end of 30 hours of work with no one to help rescussitate the lump. That is always my fear with

Radiokits, even though I really like their tiny size and overall performance. This kit will outperform everything in its price range, and I include even the venerable and excellent OHR kits in this price class (it suffers due to excess size, receive audio and 2 watt output)

Price of this kit is $99.95 + 3.75 postage. Don't go for the stripped $70 version as it does not include the very good AF filter, nor the meter, case, knobs, dial collar etc, all of which are good, and worth 30 bucks.

Dan's doesn't take phone orders because they don't accept plastic money. You have to send him a MO or check (They may wait to clear the latter so MO is fastest.) 72, Preston WJ2V

Fabricating Printed Circuit Boards

By Daniel Wee, 9V1ZV
7 Mount Sophia Road
Singapore, 0922, Singapore
daniel@pandora.lugs.po.my

Since the beginning of my electronics construction hobby, I've just about built circuits in every possible way I could think of. I still remember my early days when I actually had germanium transistors screwed down on a block of wood. That was before I acquired my first soldering iron. I then progressed to the well- known "ugly" construction technique where component leads were simply soldered together. Other methods I remember include, breadboards, matrix boards which were quite popular at one time, wire-wrapping, board-excavation and printed circuit boards. Of all these, I have found the printed circuit board method to be one of the most satisfying and aesthetically pleasing, so far. This does not mean that it was an easy method, in fact, I had avoided circuits requiring printed circuit boards until I had tried everything else, and there was a good reason for this. There are also limits to what you can produce yourself, for example, you will not have the facility to fabricate through-plated boards or multi-layer boards. For these, if you ever need them, its best to go to the PCB manufacturer to have them made for you.

Like many, I had supposed, rightly, that the fabrication of printed circuit boards was a tedious process, requiring a lot of basic tools and equipment which I did not possess. As such, the whole process of fabricating a printed circuit board had remained pretty much a mystery to me until I entered the field of radio electronics. I discovered then that the parasitic capacitance and electrical properties of other construction methods were simply unsatisfactory for circuits operating in the RF regions. Thus began my quest for the printed circuit board. The purpose of this article is to briefly outline the various methods and steps of producing a usable printed circuit board.

Basic Theory

The whole idea of making a printed circuit board is really a chemical process of removing copper from the circuit board at the right places, in order to leave behind tracks suitable for carrying current as required by the circuit in question. Boards can be bought which come with copper clading one or both surfaces, used for making single or double sided PCBs respectively. A visual survey of the board reveals an uninteresting copper surface with no holes or tracks. The constructor must find some way of removing the copper in order to obtain a circuit pattern which can be used. One way to do this is by "excavating" the board with a sharp cutting tool to remove the copper. This proves to be an extremely tedious method and can only be used for the simplest circuit patterns. It is sometimes useful for making quick and dirty modifications to an existing pattern.

The standard way of creating a pattern, however, is by means of a method known as "etching". Etching is a chemical process whereby the unwanted copper is removed by a process of reduction, a chemical reaction, which "corrodes" away the copper. This is often achieved by immersing the copper clad board into a solution of Ferric Chloride or Sodium Persulphate (I think). Upon contact, a reaction occurs which reduces the copper on the PCB to copper chloride which comes off the board. Ferric Chloride has now become a controlled substance in some places because of its toxic and environmentally unfriendly nature and this makes it difficult to obtain from the usual sources. Sodium Persulphate is the substitute for Ferric Chloride but has not arrived at the shops here yet. Either of the etchants can be obtained in liquid or in crystallized form. Nowadays, they are rarely found in liquid form because of the high rate of oxidation which renders the chemical useless. More often than not, they come in the form of dehydrated crystals which are mixed with water to produce the etching solution. This solution is then used to etch the boards.

If you have been asking yourself how the chemical can be prevented from removing all of the copper, then you have asked an appropriate question. There are a number of methods by which this can be done. The whole principle lies in preventing the etching solution from coming into contact with the copper you wish preserved on the board. This can be by means of a water-proof tape on the board, rub-on transfers, marker ink, etch-resist ink, toner ink, plotter ink or photo-resist. In short, any method that can protect the board from the chemical solution is usable. Some methods are easier than others, of course, and the method to use depends on a number of factors, such as complexity of the pattern you want to produce, the density of the tracks, the boards available etc.

Once you have, for example, drawn a pattern onto the clean copper clad board with etch-resist ink, you may immerse the board into a properly prepared etching solution for the etching process. This can take from 5 to 30 minutes or more, depending on the concentration of the etching solution. After that, the board is removed from the solution, revealing a board where the unmarked portions of the board has no copper on it, the board material beneath being now visible, and the marked parts of the board still having the ink in it. Once the ink is removed either by sanding or by the use of solvents, the copper will become visible. The one last remaining step is to drill the holes for component leads in the right places and the board is ready for use.

That is generally what happens in the process of fabricating a PCB. Time does not permit me to cover all the methods that you can use so I will highlight some of the major steps in the following text.

The Copper Clad Board

Boards suitable for etching can easily be obtained from parts suppliers and come in a number of varieties. Typically, there are two major types of board materials that are used for the base board, fibre-glass (glass-epoxy) and phenolic paper. Fibre-glass boards tend to be tougher, look better and probably has slightly lower surface capacitance properties, as well as being the more expensive of the two. Phenolic paper, on the other hand, is easier to cut and drill though it tends to crack or fragment as it is more brittle, and cheaper. Both types can be used for homebrew construction projects as the mentioned RF properties are quite insignificant until VHF frequencies and above.

You will find single-sided copper clad boards as well as double sided ones and you choose the type of board appropriate for the circuit board you wish to fabricate. Double sided boards are normally used for RF related circuits because it offers a stable one-point ground-plane which helps stability and prevents unwanted oscillations or ground loops. However, producing double-sided PCBs requires high precision tools and I will only

briefly mention some of the methods for producing simple ground-plane double sided boards later. This should be sufficient for a start.

You will also come across boards which are "pre-sensitized" or "photo-sensitized" which are used to produce photo-resist patterns. These boards are typically much more expensive than the plain boards because of the photo-resist film that has been pre-deposited over the surface. Such boards often come in light-proof wrapping with an additional layer of opaque plastic on the board surface which will not be removed until ready for exposure. I will detail this technique below.

Before you get started with the boards however, you will need to cut the board down to the size you need. Normally boards are sold in several sizes so you may pick either a large sized board and cut it up as you need, or select a size that is closely matched with your required size to minimize the cutting. The boards can be difficult or easy to cut, depending on the material of the board and its thickness. Average boards are about 2 mm thick and are quite tough and difficult to cut. Some boards come in 1 mm thickness and can be cut using a heavy-duty cutter. This type of board is usually quite flexible and thus the bending will not damage it. The thicker types on the other hand, will tolerate little bending before fracturing or fragmenting. Cutting can be achieved using a hobby saw with a fine-serrated blade. Thick saw blades are not suitable for this. Sawing should be done slowly and gradually in order not to damage the board. Saw perpendicularly to the board, which should be clamped down to the work-bench firmly using a C-clamp or a similar device. Alternatively, you can use a heavy-duty Exacto knife to engrave the border lines of the appropriate size. When using this method, it is not necessary to completely cut through the board. Once about 3/4 of the thickness has been cut, you can usually snap the board along the engraved lines. It is important to engrave BOTH sides of the board, otherwise you will not get a clean break. This method is very tedious, time consuming and tends to destroy your blade, especially when cutting fibre-glass boards. It can be used when a hobby saw is not available. Try not to scratch or damage the copper surface when doing this. After the board has been cut down to size, use a medium sized file to smooth out the edges for a nice finish.

The Etching Process

The next most important component you require is the etching solution. As of now, very few shops will sell Ferric Chloride crystals to unlicensed buyers and Sodium Persulphate is not publicly available. There is a good reason for this but it means a lot of inconvenience for the home constructor.

Ferric Chloride is most commonly available as dehydrated crystals and sold in plastic containers. It is very important to keep these crystals in a dehumidified environment as it tends to combine with moisture in the atmosphere and turn into a really messy and staining liquid. Be forewarned that this substance stains permanently on clothes and even some plastics or ceramics, is highly corrosive, carcinogenic and toxic. As such it should be kept out of reach from children and water. For the same reasons, it should not be discarded into the public drainage system.

Sodium Persulphate is a white crystal and though it is environmentally more friendly that Ferric Chloride is, similar precautions should be taken and care exercised when dealing with concentrated chemicals of any type. This substance is considerably safer however. For one, it is endothermic when dissolved in water and the resultant solution is a clear and non-staining solution. It is also slower acting than Ferric Chloride and probably needs more agitation and perhaps a little warming up. A good way to speed up the reaction may be to dissolve the Sodium Persulphate crystals in boiling water. Take all necessary precautions to avoid scalding.

The way to prepare the solution is to mix the crystals into some water, usually 1 part crystals to 5 parts water. This is just a guide and once you understand the process you can easily produce higher concentrations to etch boards more quickly. You should also be aware that the process of hydrating these crystals is a highly exothermic one so do not be surprised if the water starts to boil. As such, one should NEVER throw any substantial amount of crystals into the water. Similarly, one should NEVER add water to crystals, always crystals to water.

Normally, a plastic tray suitable for immersing the circuit board is filled with about 2 cm of water. The crystals are then added to the water BEFORE putting in the board, using a plastic spatula or any other suitable instrument. The instrument MUST be dry before applying to the crystals. Never leave the crystals exposed to atmospheric air for long. As soon as you have taken out enough crystals, wipe dry the rim of the crystal container and re- seal it in its air-tight container and store in a dry place out of reach of children. Do not get the crystals or solution on to your skin or eyes, and if you do, rinse under cold running water to remove it. See a doctor immediately in the event of ingestion. As you add the crystals to the water, the water will change color, to dark brown if using Ferric Chloride, and you should notice some heat being produced. Do not be too worried by the heat as it is useful for the etching process. Do not inhale any fumes produced during the entire process, these are poisonous and though in very small amounts, may cause asphyxiation (Chlorine). All this should be done after you have readied the board for etching. All instruments coming into contact with the solution should be non-metallic. Stir the solution until all the crystals have dissolved to produce an evenly colored solution. Now the solution is ready for use. Try to use it while it is hot so this step should always be done after your board is ready.

Put your resist-masked board into the solution slowly so as not to cause a splash. Remember that the solution is very hot sometimes. Once the board is completely immersed, regularly agitate the tray and pay attention to the exposed copper. After some time, the exposed surface will appear dull, not necessarily evenly. Then after more agitation you will see patches of circuit board becoming exposed. Do this until ALL the unwanted exposed copper surface has been removed and the board material is visible beneath it. This may not be easy initially as the etching solution may obscure your view of the board. It is therefore good to have a deeper tray which allows you to tilt the tray to expose the board. Normally, surfaces with less exposed copper tend to etch faster that surfaces with more copper, and once you are more experienced, you may want to use a stronger concentration for surfaces which require a lot of etching. The copper corrosion normally starts from the edge of the board and works its way to the center. Be sure to keep on agitating the board so that the resultant copper chloride (a powdery precipitate black in color) will get swept off the surface. This will speed up the etching process.

While it is important to make sure every part of the board is sufficiently etched, DO NOT keep the board in the solution longer than absolutely necessary. This is because extended exposure will allow the etchtant to get under the resist and affect the fringe of your tracks, resulting in ugly patterns. Experience will soon tell you how long to leave it in for the concentration you use. Normally everything should be done in 25 minutes but it may be less, depending on the size of the board, exposed surface, and the concentration of the solution. Proper timing is especially important when very thin running tracks are involved.

If you are doing double sided boards, you should at some point, turn the board over. In this case, unless you have special holders, you should not over agitate the tray as the copper chloride precipitate which sinks to the bottom of the tray is rather abrasive and may scratch off some of the resist on the bottom side. Other than that, the procedure

remains the same.

Some of the shops sell special etching tanks which stand vertically and have a little electric motor to automatically agitate the tray. This is not suitable for small scale productions as the tank normally requires large amounts of etching solution to fill up, and cost quite a lot to buy. For me, the above method is more than sufficient.

Drilling of Holes

The drilling of holes is typically the last stage of the PCB fabrication process so this may seem a little anachronistic. Nevertheless, this is the last common step of the various methods of PCB fabrication so I thought it'd be good to cover it now.

Clearly, you will need to drill the holes yourself if you intend to put components on the board. In some surface-mounted designs, especially common with microwave and UHF circuits, this may not be necessary. Unfortunately, you cannot use your trusty Black & Decker power drill for this purpose because of the excessive speed of the drill and the oversized drill bit. A hobby or hand-drill is suitable and cheap ones, both battery powered and mains powered, can easily be found in Singapore for under $50. You will need to get a few common small sized drill bits for PCB use. The most useful by far is the 0.8 mm drill bit. The 1 mm and 2 mm drill bits also come in handy when drilling larger holes on the PCB. Generally, drilling PCBs do not require a lot of effort because the PCB material is relatively soft and easy to drill. Be sure to get spare bits because the bits tend to break easily and are rather brittle due to their small cross-sectional area.

You should position the drill bit perpendicularly to the PCB for drilling any holes, and always maintain a steady and firm grip of the drill. If necessary, you may want to use a sharp instrument to slightly indent the spot you want to drill, as a guide as sometimes the drill bit tends to spin away from the point and scar the rest of the copper surface. Usually though, properly made boards should have these guides etched in. Do not apply undue force as this might cause the bit to break or the board to crack. Apply a steady force on the drill until you feel the penetration of the PCB. It is also advisable to have a piece of unwanted even wood surface beneath the board so that you won't destroy your workbench or your drill bit. Soft-wood is best but other soft material will also do, eg. old hard cover books.

Normally the drilling process produces a substantial amount of debris which will obscure your drilling template. Thus you will want to drill holes systematically so as not to miss any holes inadvertently, and to drill a section at a time, clearing away the debris as they accumulate. Do not have the fan blowing while you are doing this or your XYL will be all over you for messing up the place! Once you have drilled all the holes, inspect the board for undrilled or partially-drilled holes. Also, be on the lookout for tracks that may have come off as a result of the drilling. This may sometimes be the case when drilling large holes on a small pad. Remove burrs from the holes and then your board is ready.

Masking the PCB

As was mentioned in the basic theory section, there must be a way of controlling which parts get etched and which parts of the board don't. I also briefly mentioned a number of methods. Here I will highlight two of the methods most relevant to us homebrewers. Direct penning onto the board using etch resist pens and photo-resist.

Using Etch-Resist Pens

You can actually draw the desired tracks or patterns onto the copper clad board with etch resist ink. Get a normal copper clad board that has been cut down to size, washed

and dried completely. Do not soak the board in the water for too long or the water may damage the board. Be certain to make sure that there is not grease on the board or oxidized surface. If necessary clean the board with some mild abrasive to obtain a shiny surface. Avoid touching this surface with you fingers or dirtying it. This will ensure a more even etching later on. There is no need to buy special etch-resist pens for this purpose though you could do so. For simple purposes, permanent markers or Indian ink seems sufficient for the job. There are advantages and disadvantages of using such a method. On the plus side, this is a very convenient method for producing one-off, not too intricate or complex patterns, and can be done rather quickly. However, you cannot obtain high resolutions tracks or any degree of evenness with this method. The results tend to look amateurish. Just as a reminder, the tip of the etch-resist pen tends to dry up quite quickly so the pen should be re-capped tightly when not in use. Have a pice of paper near by to get the ink flow even before trying to mark the PCB with the pen.

Sometimes you can buy rub-on transfers for tracks or pads which you can incorporate as part of your pattern to make it look neater. On the whole, however, this method is reserved mostly for experimentation or very simple circuits with broadly spaced tracks. Alternatively, you can also use special tracking adhesives to paste out your tracks. Either way, the end result is rather coarse and difficult to reproduce.

Recently, there are available in the United States, special transparencies which you can laser print or photostat your track onto, and then iron-off the pattern from the transparency onto the board. Below is an excerpt which says something of this method:-

From: gary%ke4zv.UUCP@mathcs.emory.edu (Gary Coffman)

There is a special transparency film called Tec 200 marketed for this purpose, but I've found that Avery overhead transparency film works just as well, and is available at most larger computer or office supply stores. You just print your board layout to the transparency with your CAD package laser driver, remember you want a mirror image, and then iron it onto the copper. The copper needs to be clean, just as it would be for any resist application. You need a fairly hot clothes iron to fuse the toner to the copper. I use a regular home iron set for "cotton" and use an old Tee shirt between the iron and the film. After it cools, you can peel the transparency film off the circuit board and the toner will remain behind as the resist pattern. There may be a few pinholes or gaps where the toner didn't transfer well. You can patch them up by hand with an ordinary resist pen.

Note you can also use Avery film in ordinary copiers to generate a transfer from magazine artwork or hand drawn paper layouts. Of course when laser printing the film, you need to adjust your CAD driver so that the laser printer gives a properly dimensioned copy, and when using a copier, one with infinitely adjustable "zoom" feature is handy for the same purpose. If the artwork is "normal", you can first make a copy to a transparency, flip it over, and use that as your master for making the transfer transparency.

Works good, costs little.

Another method I have come across of directly masking the PCB is through the use of flatbed plotters. Apparently, the ink used in these plotters are etch-resistant and if you can design the board using CAD software, you should be able to plot the mask directly onto the board using the plotter. I have not tried this myself but a friend of mine has and reports good success.

Photo Resist Masking

This is probably the best way I know for making nice looking PCBs. Unfortunately, the technology behind it is rather obscure for many people entering the hobby and remains a mystery for others. Thus I will try to demystify the process here, with some luck. Contrary to the belief of many, the photo-resist method does NOT produce tracks on the

PCB, it only produces a mask or pattern of etch-resist material, after which the board still needs to be etched like in all the other methods.

In this method, you need to get your pattern or mask onto a piece of clear transparency. This is usually done by laser printing direct on to the transparency, or photostating on to it. This means that anything that can be photostated, eg. patterns from magazines or from the ARRL handbook, or even texts and pictures, can be etched. This adds a number of advantages. For one, it is much easier to draw patterns on normal paper than on the copper surface. There is no need to use special etch resist ink for this purpose. You can also draw lines with higher density and definition as well as accuracy than you can using the direct method. You can use PCB layout software to print out computer generated patterns as well as including printed texts as part of the pattern. The possibilities are numerous. It should be noted that all the patterns must be black and white, no grays, and that the transparency must be clear, clean and colorless. Transparencies used for OHP presentations are suitable for this purpose. As an additional hint, you should try to get the transparency prepared such that the side with the toner is also the side that will be in contact with the PCB during exposure. This yields slightly better defined lines as there is then only one clear edge. It does not matter that the print is not completely opaque when you look at it against the light, usually normal photostat contrast is sufficient. You may want to cut the transparency to the size of the PCB for easier handling. Do not scratch the transparency as the toner may come off. If you notice missing tracks, you can still fix it by drawing on the missing tracks using an opaque black marker pen. If you notice excess tracks, slowly scrape off the toner/ink gently using a paper cutting blade. One advantage is that once you have produced one mask, you can use the same mask to produce a number of identical boards. When producing the mask, you should try to get it so that the emulsion side (the print side) is the side that contacts the PCB. This way when you expose the board, there is a minimum of shadow and fringe effect at the edges of the tracks and results in higher definition tracks.

The copper clad board must be specially prepared or sensitized by spraying a film of photo-sensitive masking material on to it. This spray is normally available in a canister and leaves a coat of clear green color (usually) when applied to the board. Spraying must be even and a sufficiently thick film must be deposited and dried before commencing exposure. All this should be done in low light/UV conditions as the spray is photo-sensitive. Alternatively, and more conveniently, boards that have been presensitized can be purchased quite easily from the shops. In any case, the spray is very expensive and not easy to use. These pre- sensitized boards come in light-proof wrapping which you may remove. The boards have a second protective plastic film over the surface so you need not worry about accidentally exposing the boards. The rate of reaction is way slower than that of the camera film so you need not be overly concerned of over exposure. Just be sure that you are not doing this under intense fluorescent or sunlight. The second protective layer is an opaque adhesive plastic layer which is stuck to the board surface. This is usually white in color. Do not peel off this layer until you are ready to expose the board. If you do accidentally peel it off pre-maturely, store the board in a dark place until you are ready. In any case, these boards need to be stored in the dark and in a cool environment.

Once your transparency is ready and you have cut the board to size (without removing the protective layer), prepare yourself a clear piece of flat glass such as that found in picture frames. Be sure that the glass surface is clear and clean, and that its size exceeds the size of the PCB. This glass is used to hold the transparency to the PCB during exposure. Put the PCB on a flat surface and align the transparency over it, making sure that when you look at the transparency, you see the exact image of the track/pattern that you

want, NOT the mirror image NOR the negative. Be sure your UV source is NOT active. Once you are ready and have double-checked every detail, slowly peel off the protective layer from the pre-sensitized PCB and replace it on the flat surface. Under the protective coating you should see a hard and dry, green film over the copper. Place the transparency correctly over the PCB and align it. Then, place the piece of glass over the transparency to press it firmly to the PCB surface. Once again check your alignment and then expose the board to the UV source.

The UV source can be a table top fluorescent lamp, or the sun, or special UV lamps. In all cases the UV content is not the same, thus exposure time varies. In my case, I use a table top lamp with an 11-watt fluorescent tube and place it about 2 to 3 inches above the board for 6 minutes to give me a properly exposed board. Under the afternoon sun on a clear day, it takes about 8 to 15 minutes to get sufficient exposure. Under UV lamps, the period may be as short as 30 to 90 seconds depending on the intensity of your source. Experimentation is the key to knowing how long to get the right exposure. Excessive exposure will damage the board and under-exposure will be equally disastrous. Once you have determined the correct exposure time, however, it is the same every time when using the same type of board, so be prepared to experiment a little with your first few boards. NEVER move or adjust the board once you have started exposure. Once you get good at it, you can even expose a number of boards simultaneously. Some types of board will exhibit a slight color change on the exposed parts once they are done but do not count of this method to determine when to end because the change is barely perceptible. Note that if you are using a UV lamp, be careful not to look at the light direct as it may damage the eyes because the iris of the eyes do not respond too well to UV and may result in retinal burn.

During the few minutes of exposure, get the developing solution ready. This solution is normally sold in the same shops where you purchased the PCB in the first place. They sometimes come under the name of POSITIV 20 or something similar and consists of an alkaline solution. Have this ready when you finish exposing. If you observe the board carefully, you may notice that the exposed portions are a little lighter green in color than the masked portions. This allows you to actually see a faint trace of your masking pattern on the exposed board. Rinse the exposed board in the developer solution and if properly exposed, you will see the exposed parts of the green photo-sensitive film dissolve in the developer solution. Once the unwanted parts have been completed dissolved and washed away, rinse the board under cold running water to remove any remaining developer solution. You should now see a very clearly defined, green, image of your original pattern on the PCB now. Dry the board carefully, making sure that you do not accidentally scratch off the resist/film. At this point you can still make corrections to the pattern using etch-resist pens or by scraping off resist/film from excess sections. Once everything has been confirmed, put the board aside and prepare for etching as outlined above.

Making your own PCB layout masks

There are a number of ways you can use to produce your own photo-exposure masks and layouts. Typically you want to draft out the layout on paper first before committing it to the final mask. Be sure to take into consideration RF paths and good grounding. There are a lot of considerations that need to be taken into account of in the design of a good PCB layout. Once you have drafted out the layout you can use hand-drawn masks, or combine hand-drawing with the use of Decal-Dry or rub-on transfers. These methods are suitable only for low density/complexity designs. The easiest way however is by the use of CAD software. There are some easy to use but fairly competent PCB CAD shareware

available and if you intend to produce PCB designs of your own, you should be familiar with such software. Describing how they work is outside the scope of this article but among the features of such software, are their flexibility, multiple printer support, multiple layer support, silk-screening support, automatic drill guides on pads, auto-routing, easy editing, free/shareware, standard component templates and the list goes on and on.

Summary

In summary, let me outline the steps and tools involved in the direct PCB fabrication method. First, the tools and materials:-

a) Ferric Chloride or Sodium Persulphate crystals (or solution).
b) A plastic tray big enough to immerse the board fully.
c) The single or double sided copper clad board.
d) Etch resist pen and/or transfers.
e) A small medium speed drill with 0.8 mm bits.
f) Hobby saw or Exacto knife to cut the PCB down to size.
g) File to give the board a good finish.
h) Mild abrasive for removing the resist from the PCB after etching.

The steps involved are as follows:-

a) Prepare a draft of the desired layout.
b) Cut out the required size of the copper clad board.
c) File the edges of the cut down board for a smooth finish.
d) Transfer the layout to the copper clad board by drawing it on with the etch resist pen or transfers.
e) Double check for errors.
f) Prepare the etching solution as by adding 1 part crystals to 4 or 5 parts water. Refer to section on etching.
g) Immerse the masked board into the tray with the etching solution.
h) Agitate the tray slightly for about 15 to 25 minutes, paying attention to the extent of the etch.
i) Remove board from tray when completely etched.
j) Rinse board under cold running water from the tap.
k) Dilute used etching solution with lots of water before disposal.
l) Use the mild abrasive to remove the etch-resist from the board.
m) Use the drill to drill the appropriate holes for the components.
n) Remove burrs from the holes.

For the photo-resist method, the tools required are the following:-

a) Ferric Chloride or Sodium Persulphate crystals (or solution).
b) A plastic tray big enough to immerse the board fully.
c) Pre-sensitized copper-clad board.
d) Transparency suitable for photostating.
e) UV light source.
f) Developer solution.
g) A piece of clear glass to hold mask in place.
h) Marker pen or transfers.
i) A small medium speed drill with 0.8 mm bits.
j) Hobby saw or Exacto knife to cut the PCB down to size.
k) File to give the board a good finish.

l) Mild abrasive for removing the resist from the PCB after etching.

The steps involved in the photo-resist method are as follows:-

a) Prepare the masking pattern on a piece of white paper.
b) Transfer pattern to the transparency by photostating.
c) Cut the pre-sensitized board down to size.
d) File the edges to remove unevenness.
e) Place transparency on the board to check alignment.
f) Peel of protective layer from board.
g) Align the transparency on the board.
h) Place glass over the transparency to hold it firmly in place.
i) Place the UV source over the board and glass.
j) Activate the source and expose board for a suitable period. Read above.
k) Rinse the exposed board with the developer solution to dissolve unwanted resist.
l) Double check for errors.
m) Prepare the etching solution by adding 1 part crystals to 4 or 5 parts water. Refer to section on etching.
n) Immerse the masked board into the tray with the etching solution.
o) Agitate the tray slightly for about 15 to 25 minutes, paying attention to the extent of the etch.
p) Remove board from tray when completely etched.
q) Rinse board under cold running water from the tap.
r) Dilute used etching solution with lots of water before disposal.
s) Use the mild abrasive to remove the etch-resist from the board.
t) Use the drill to drill the appropriate holes for the components.
u) Remove burrs from the holes.

Conclusion

The real key to learning to make PCBs is to do it yourself. In this article I have tried to provide a general idea of the process of fabricating your own PCBs and have purposely included a number of cautionary and warning notes so that the reader will be aware of the hazards involved. On the other hand I have been making my own PCBs for about 8 years now and have not suffered any side-effects or harm. Hopefully, this article will open new doors and possibilities for the homebrewer and that through homebrewing, one very significant aspect of the original spirit of Amateur Radio may be restored. If there should be further inquiries, I will be more than glad to help out. 73, Daniel Wee

The Key 7 - Opening the Door to Milliwatting

by Steve Ortmayer, G4RAW

[Editors Note: This article was originally published in the April 1995 issue of Practical Wireless. It is a British amateur radio publication, and is an excellent addition to your library. Rob Manion, G3XFD, is the publisher, and is quite active, both on the air and at ham fests. He attends Dayton yearly, in fact, Practical Wireless sponsors an annual tour to Dayton from England. Subscriptions to Practical Wireless are $45 per year for 12 issues. If you would like to subscribe send a check or money order made out to Practical Wireless for $45, US funds. The address is: PW Publishing Ltd., FREEPOST, Arrowsmith Court, Station Approach, Broadstone, Dorset BH18 8PW. I recommend the publication

highly, it is one of my favorite! Thank you to Rob Manion for kindly granting permission to republish this article. KI6DS]

Personally, I've never felt the need for more than a few watts output since I obtained my call in 1983. But I had never tried less than about 1W. Would it be possible to make contacts with 100 mW? I had read in Sprat, the journal of the G-QRP Club, that QSO's have been made with very low power but they may have had some good high gain antennas.

My antennas are very simple wires strung between the chimneys of my house. During one 3.5MHz QSO I mentioned to the other station that my antenna was a half wave inverted V on the chimney, and he came back asking "Is it a mill chimney?".

Apparently, he had thought I said a half wave vertical! Well, most of the mill chimneys have gone now in Halifax. "Good thing too!" say the generation who slaved in them.

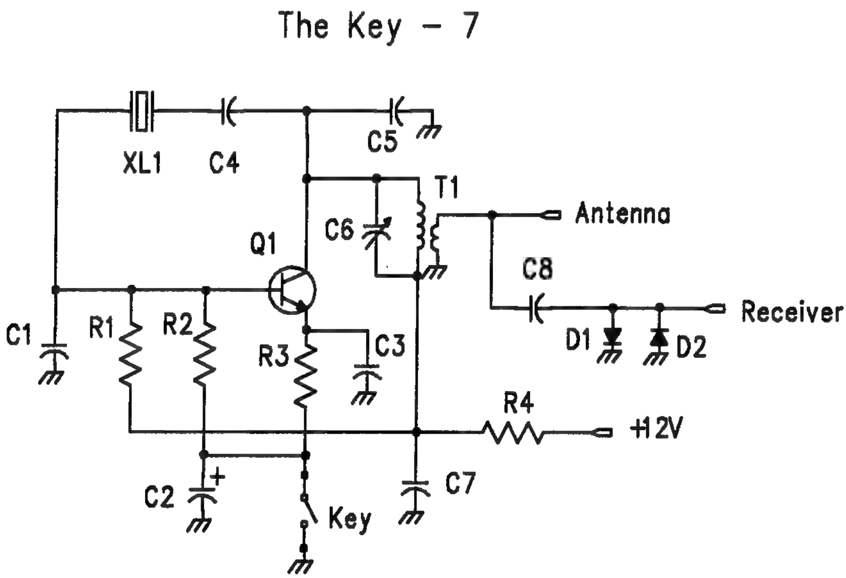


Figure 1

The circuit, Figure 1, for the transmitter is a simple one transistor oscillator and it comes from Doug DeMaw's W1FB's Design Notebook. I made two versions of the transmitter, and one used my well known drawing pin method, on a wood base with a strip of p.c. board material as a Morse key.

The version I'm describing this time is the other one I made, using a p.c. board. With this method the board is extended to form the key as in my original PW Speedbrush Morse key project.

If you would like to try the drawing pin version a wood base is prepared and the pins pushed in, following the circuit layout. The pins are tinned with solder first, but take care not to overheat them, an aligator clip can be used on the leads as a heat sink.

When all the components are in place, check the wiring and apply 12V, not forgetting that a dummy load 50 ohm resistor should be across the output. The output can then be measured with a diode probe.

Adjust C6 for maximum output which should be about 100mW. If the transmitter does not work, check the crystal and if this is in order, try changing C4 to 120pF.

You can make the p.c. board version in the usual way by copying the layout onto a bit of copper laminate board. Glass fibre board (this is the material which the appropiate PW PCB Service boards are made from) is best. This is because it has mor "springyness" for use as a Morse key.

If you're making your own board, first etch and drill the board and solder in the components. If you've got the ready-made p.c. board, drop the components into place, using Fig. 2, the p.c. board layout and component overlay as a guide.

The p.c. board is then bolted onto a wooden base with a small plastic knob to form a Morse key. The transmitter is then ready for testing.

I tried and tested a 2N4400 transistor which gave about 100mW and a 2N2222A whcih gave about 50mW. The transmitter was connected to the receiver with a 100pF capacitor (C8).

The diodes, D1 and D2, 'clip' the RF to the receiver. The capacitor C8 can be adjusted to give full output of weak signals, but too much will make the receiver thump during transmitting.

Personally, I think it's a big help to be able to listen to the signal, as it indicates all is well with the transmitter. The 100pF capacitor at C8 worked well with my simple home-made receiver.

How did the little transmitter work on the air? Well, I'm pleased to say I've got some QSL cards which are interesting. Working from my QTH in Yorkshire I had comments like: "No problem copying your 100mW from Tony, G0KPB (Derbyshire). And another saying "Very pleased to work your 100mW station" said G6NA (Dorset) who was using a Solar powered 500mW!! The 50mW version brought 579 reports from G0FPV in Essex. So, milliwatting does work...have a go and enjoy yourself. 72, Steve

Clive Hardy, G4SLU, built the PW Key-7 prototype, and provides some comments and advice on the project: Of the build options for this transmitter I chose the p.c. board version. To me, it seemed the more interesting. It certainly takes up less space than the drawing pin type. Whilst the circuit is the same as the original, the layout is not exactly the same as the published p.c. board pattern. This because when building the transmitter I only had the rough draft p.c. board drawings to work from. Fortunately, at 7 MHz component positioning doesn't matter too much, within reason.

I used the more readily available 2N2222A transistor and got the same 50mW that Steve die with the device. By increasing the number of turns on T1 Secondary from 3 to 5 turns I obtained just over 100mW output from the 2N2222A into 50 ohms. No doubt with the appropriate number of turns for the link winding 100 mW could be obtained from most small signal transistors.

Finally, in Steve's instructions he states the secondary of T1 should be wound near the 12V end of the winding T1. I didn't think winding position was that critical with a toroid, other than it should be evenly spaced. My link winding is reasonably close to the 12V end of the main winding, but when I was experimenting with the number of turns the results were the same whereever the turns were.

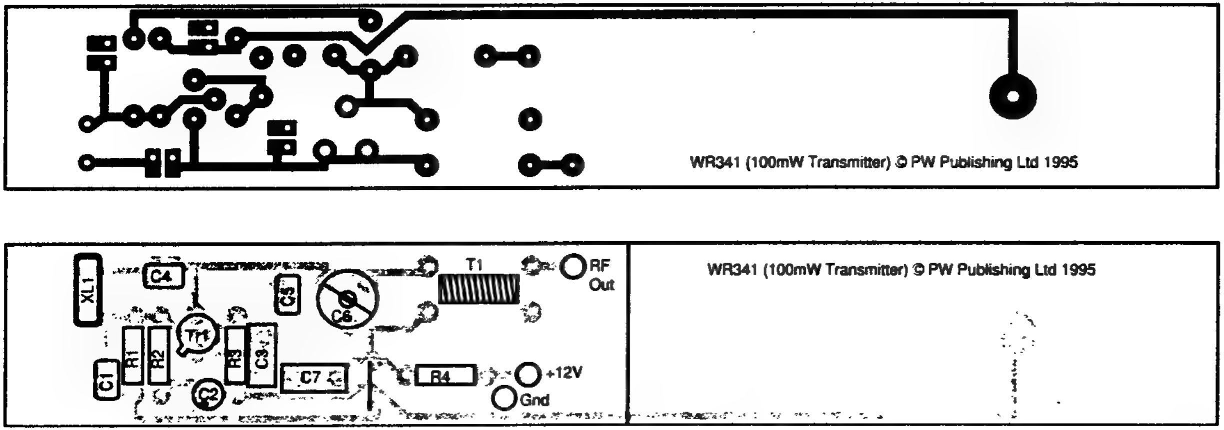
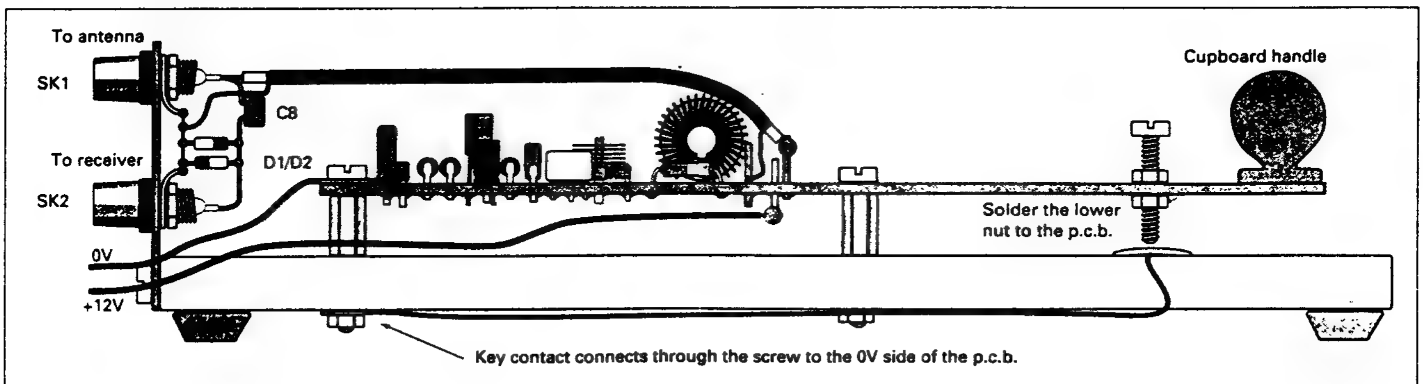


Fig. 2: The p.c.b. and associated component overlay for the Key-7 transmitter.



Parts List

Resistors:

R1	22K
R2	8.2K
R3	150 Ohm
R4	10 Ohm

Capacitors:

C1	27pF Disc
C2	2.2/25V Electrolytic
C3	0.1uF Disc
C4	100pF Disc
C5	270pF Disc
C6	100pF Foil Trimmer
C7	0.1uF Disc
C8	100pF Disc

Semiconductors:

Q1	2N2222A
D1	1N4148
D2	1N4148

Inductors:

T1	Primary 24T #26 Enameled wire on T37-6 (yellow) Secondary 5T #26 Enameled wire on T1 primary.

Miscellaneous:
Crystal, 40 meter band, crystal holder, pc board, suitable wooden base, drawing pins (thumb tacks) for drawing pin version, knob for Morse key, wiring, antenna sockets, 1/2 inch spacers, rubber feet, nuts and screws for hardware.

Another RFI Case Solved!

by JC Smith, KC6EIJ
1249 Dewing Ln.
Walnut Creek, CA 94595

Working QRP with a simple homebuilt rig is truly one of the greatest pleasures in ham radio, but you do have to work at it a little harder than with the big commercial rigs with noise blankers, selectable filters, IF shift, etc. not to mention 15 to 18 dB more smoke in the coax. Add severe local QRN to the mix and suddenly it isn't as much fun anymore. That's the problem that had been confronting me for over six months.

The noise was a loud hash, sort of a frying sound. The wider the bandwidth, the worse it sounded (on AM it would hit 20 dB over S9) but even on CW the noise blanker on my "big rig" couldn't knock it out. It wasn't there all the time, and wasn't always continuous, but there was no discernible pattern like you get with a thermal cutout on a malfunctioning transformer. it seemed to be in the late afternoon and evening that I heard it most often. (Prime operating time for many of us.) I tried the obvious: pulled the breakers at the service entrance and powered the rig via battery...no change, it wasn't coming from my QTH.

I got out the AM transistor radio and started walking the neighborhood. Those little

things are surprisingly directional, and the nulls of the little internal antenna are very effective at pointing out any receivable signal source. It was everywhere: power poles, service entrances, phone or cable drops, guy wires, everywhere. I called PG&E (our local utility) and they said they had someone who could help me, but first I had to fill out a questionnaire and wait "a few days". The questionnaire was simple and informative, and might even help someone locate their problem, but I had already tried everything they suggested so I sent it in and waited. And waited... and waited. Finally I decided to take matters into my own hands.

I started listening at regular intervals and keeping track of when it started and stopped. Whenever I heard it I would tune the HF rig to AM on 10, 15 and 20 and swing the beam while watching the S meter. This told me a few things: the noise was starting at around 4 PM weekdays, not so regular on weekends, and was continuing until 9 or 10 at night. Rain didn't seem to affect it, but wind did. Best of all, I was able to get a bearing on it, about 330 degrees from my location (again, the nulls were more effective than the peak in pinpointing the direction, but the peak answered the question of which of the two nulls was the correct one). I also learned that you can find out where your antenna is resonant by tuning the band and noting which frequency the QRN peaks at. Guess I should have known that, but it never occurred to me before.

Now i got out the little AM radio again and started driving in my truck all over the neighborhood to the NW of my QTH. I would hear the noise whenever I got near a pole, but about five blocks from home I started to hear it much louder. I parked the truck and started walking and soon found the offending pole. The racket from the radio was deafening. On the pole were a bunch of cable TV junctions and an amplifier. I thought I had found my problem. I even came back to check this pole when the QRN was silent. So was the pole.

I called the cable company and politely told them they had a leak. They sentsomeone out right away and we drove to the location. He had a scanner set up to scan all their frequencies, and he found a small leak on the next pole over, but said the noise we were hearing on my radio was not from their equipment. That left the electric utility company. I called them again only this time instead of saying I was having RFI problems, I told them I had located one of their insulators that was arcing (I lied, I admit it) and could they connect me to an engineer in service. This worked, and the engineer asked how I knew about this problem. I turned up the volume on the radio and held the phone near the speaker. I also said I had located the pole with the problem. He said he would try to get someone out here right away, and about two hours later a service technician showed up.

At first he didn't believe me when I said the problem was five blocks away. He assumed it was one of the nearby poles on my street. He did, somewhat reluctantly, agree to drive to the location. When we got there, the radio was screaming again and he became a believer. H confirmed the problem in a simple manner I hadn't thought of: he grabbed the guy wire (this was an end pole) and gave it a vigorous shake. The steady QRN on the radio became intermittent as he shook, and then went back to steady when he stopped. Problem found. Not an arcing insulator, but a bad connection that would heat up under load (when people started getting home in the evening and turning on all their appliances) and break down. When the load was reduced it would cool off and the problem would go away. A few days and a bucket truck later the problem was solved. The utility company was actually grateful, and thanked me for finding the problem for them, but nobody was more grateful than I was to be rid of that infernal noise.

So is this what is causing your QRN problem? Maybe, but probably not. There are more likely sources such as dimmer switches, doorbell transformers, touch lights, etc, etc. The main thing to learn from this is that you don't have to live with excessive QRN. If you

live in an urban area you have to learn to live with more background noise than those fortunate enough to live out in the country, but 20 over S9? NO WAY! Remember, the FCC doesn't issue licenses for spark gap transmitters. We hams have a right to reasonably quiet operating conditions on most of our bands. Be persistent, be polite, read everything you can find on RFI location & elimination, and never underestimate the lowly little AM "transistor" radio with it's built in beam antenna. 73, JC Smith, KC6EIJ

OPERATING SKILLS: For the QRP Operator

by Byron Johnson, WA8LCZ
27426 Winslow
Warren, MI 48092
Byron8LCZ@aol.com

QRP OPERATING SKILLS:

1. Listen to existing QSO's, pick someone to call (station A), put your vfo exactly on the other guys freq (station B), now station A will hear you when station B signs off and you can him, because you're exactly in his receiver bandpass. Most cw ops use narrow filters (500 Hz or less)

2. If you want to work DX, pick a low angle of radiation antenna, like a vertical mounted in the clear or a dipole installed at the proper height (one half wavelength at your operating frequency for 40 meters, thats 20 meters or 66 ft) above ground, for the frequency you intend to transmit on. If you want to work a local contest, and DX isn't coming in, pick a high or medium angle antenna to improve your chances of making a lot of mostly local contacts.

3. Listen a lot, get to know how propagation works, pick the right frequencies for the stations you want to contact. (Your chances of working Russia are much better on 14 or 21 MHz in the middle of the day than 3.5 or 7 MHz.

4. Monitor the DX packet cluster (on two meters) to see what frequencies are active with DX.

5. The Rules don't always work the way they should. Don't be afraid to experiment if conditions arent working the way you think they should. Sometimes solar flares or local weather conditions can change reception to your area of the country. There are times when calling CQ is the only way to check out conditions. When TV or two meter reception is unusually good or bad, check the HF ham bands to see how it effects the DX. Listen right after a thunderstorm, after the lighting stops. I've heard Austrailia and Easter Island very loud, they couldn't hear me. strange conditions. If everyone's listening and no one calls CQ, not many QSO's will occur.

6. Put up the best antenna you can afford, buy the best receiver you can find, learn how to use both. don't rely on antenna tuners, they won't improve your antenna. Get your code speed up to the average speed most ops are using (15 to 20 wpm minimum), calling CQ DX at 8 wpm will get very few replies.

7. If conditions are poor, don't ragchew, send RST, name, QTH and turn it over. listening to other ops with poor proceedures won't help you. be brief, there are probably a hundred

others that also want to work the DX.

8. Don't practice your code on the air, don't learn how to use a new key on the air, don't tune up for minutes on the air, be considerate of others and they might do the same. If you tune up with a series of dits for minutes at a time, others will soon follow.

9. "Always" listen on a frequency before you tune or call CQ.

10. At field day, check out the cw ops, some of them are terrific operators, you could learn a lot in one weekend.

11. If the band is opening, signals will get stronger, so answering a weak signal is fine. if the band is closing, you should probably avoid weak signals unless its a needed state or country.

12. QRP Contesting is a great way to improve your skills, code speed, fine tune antennas, rigs, filters, keyers, logging methods. Learning to use IF filters, audio filters, IF shift or passband features on your transceiver, finding ways to change bands and antennas quickly without a tuning proceedure. So you can spend more time operating and less time fiddling with knobs. Its also a lot of fun.

13. Match you sending speed with the other guys CW speed. I keep my iambic keyer on my left side, so I can adjust the speed while I'm sending with my right hand. If he calls CQ at 15 wpm and you go back to him at 20 wpm, he probably won't answer you.

14. I like to be on a band before it opens, so I hear the DX first, work him and then sit back and listen to the pile up. Then I move up in frequency and catch a few more QSO's with others after they're worked the DX. I also hang around after the band dies, because it never really dies completely at one time. Sometimes these techniques work well.

15. Don't always listen at the same time every night. Change your operating schedule to include some late nite and early morning listening. The weekends are also a terrific time to be on the air. DX stations are in every time zone around the world. To work lots of DX, you need to be flexible.

16. Get a copy of "The Complete DX'er" by Bob Locher W9KNI, its a great read and has dozens of ideas to improve your chances of making lots of contacts and finding DX.

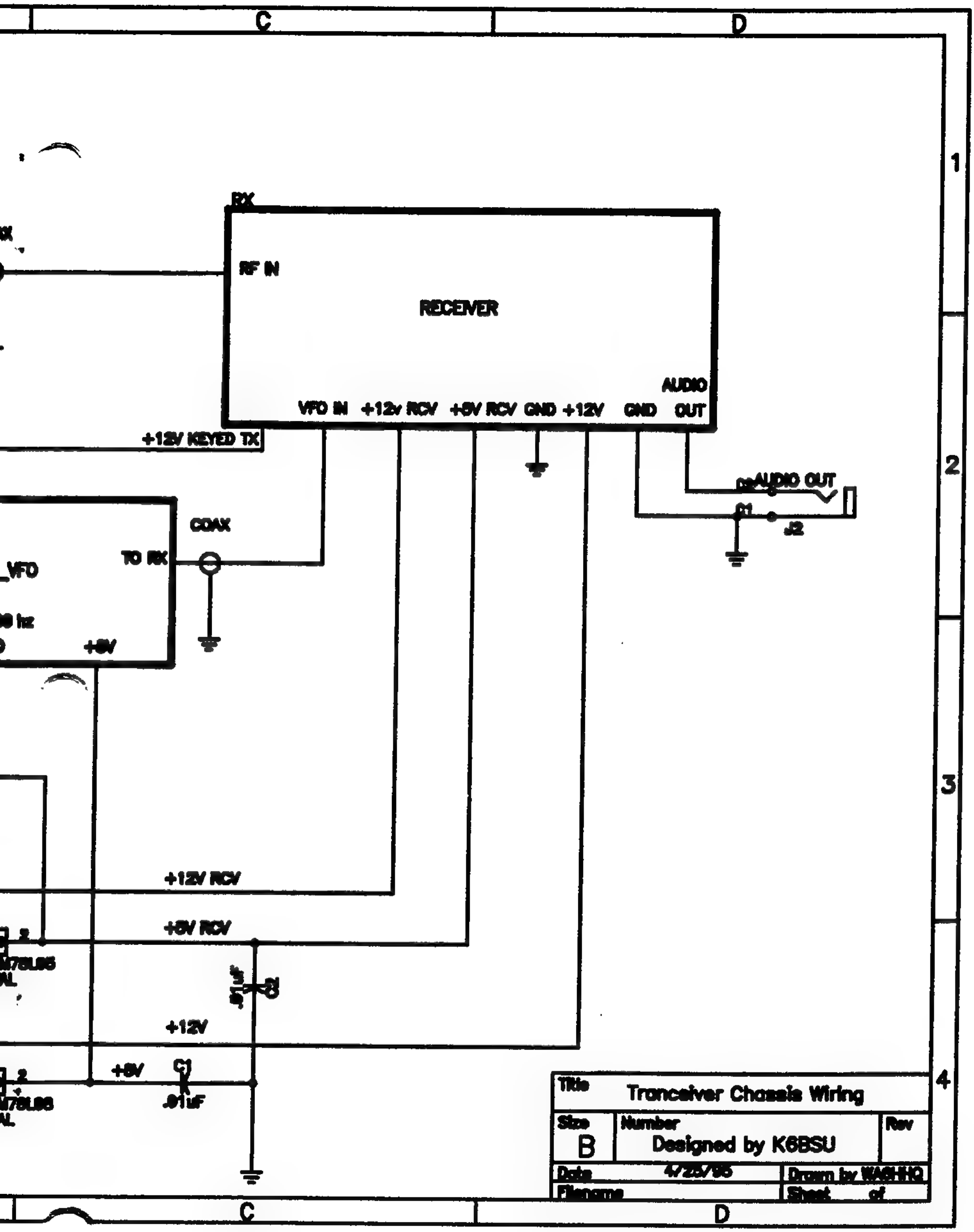
72, Byron Johnson WA8LCZ

73 SPECIAL

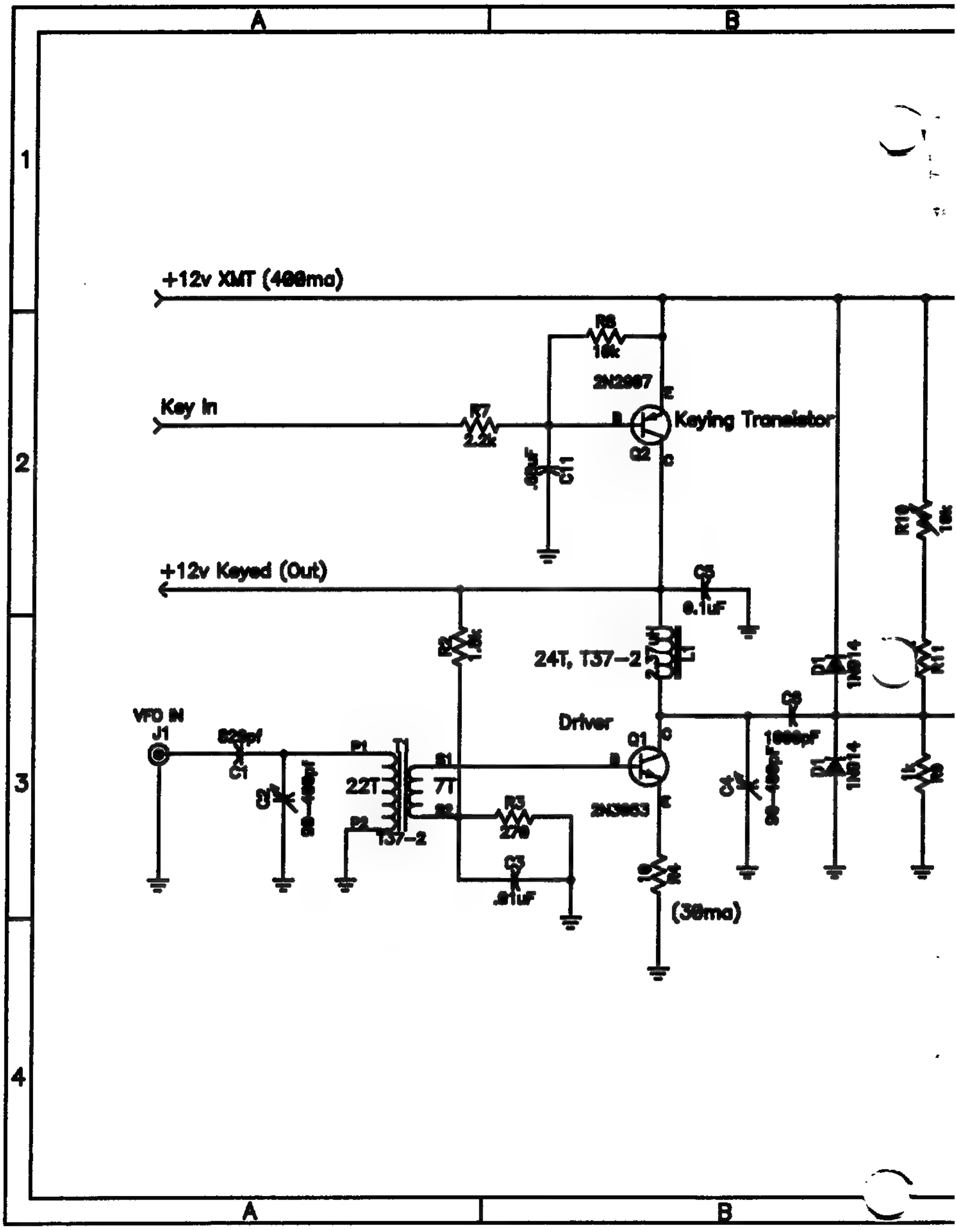
Floyd E. Carter K6BSU
2029 Crist Drive
Los Altos, CA 94024

The 73 Special is a complete 40 Meter CW transceiver which comfortably fits into a 7" X 5" X 2" cabinet, including a 10-cell, 12 volt 600 mah NiCd battery pack. Add only a key and a wire antenna for QSOs during a Sunday picnic outing in the park or a backpack trip.

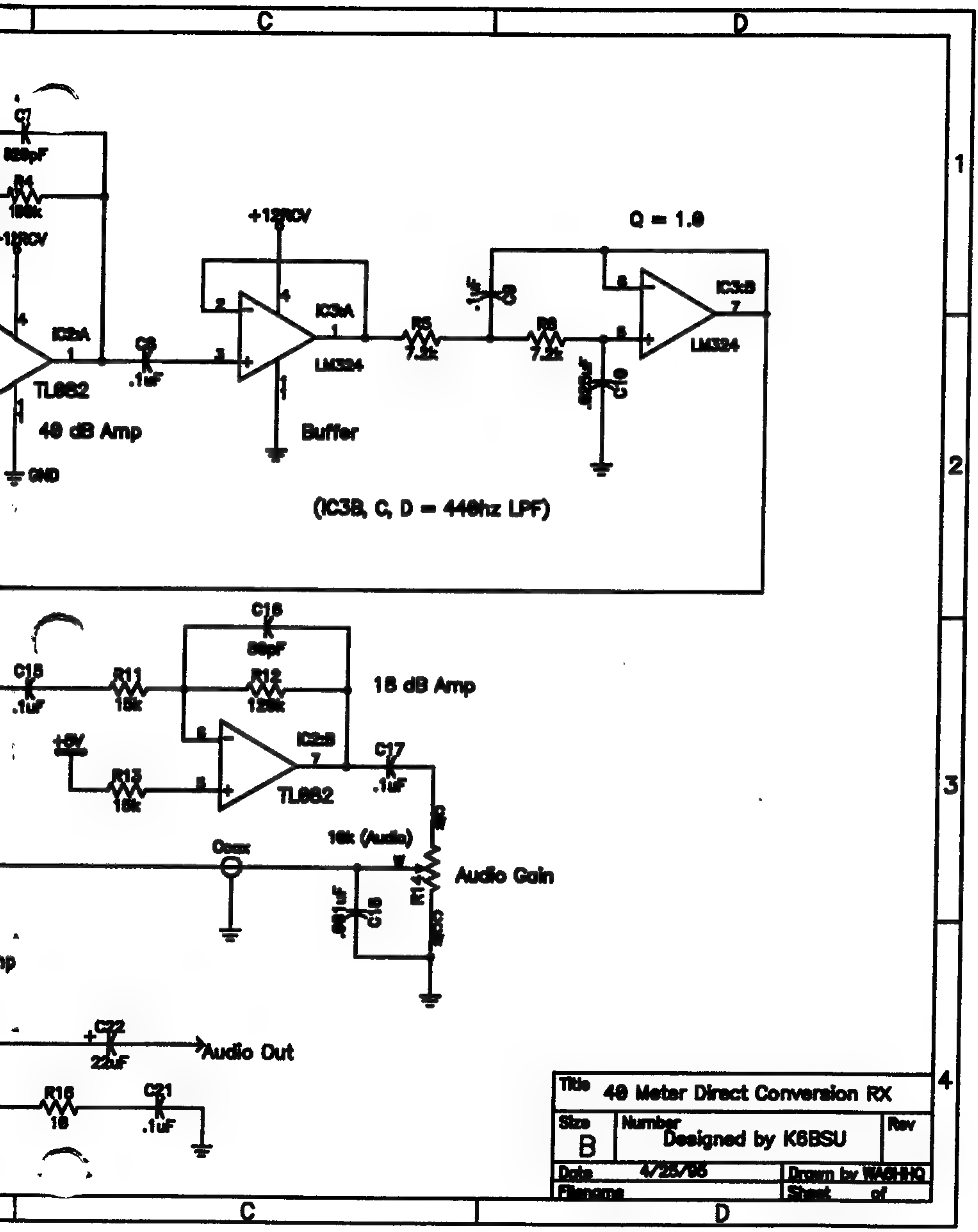
The 73 Special got its name because it delivers 3 Watts output at 7 MHz. Unlike

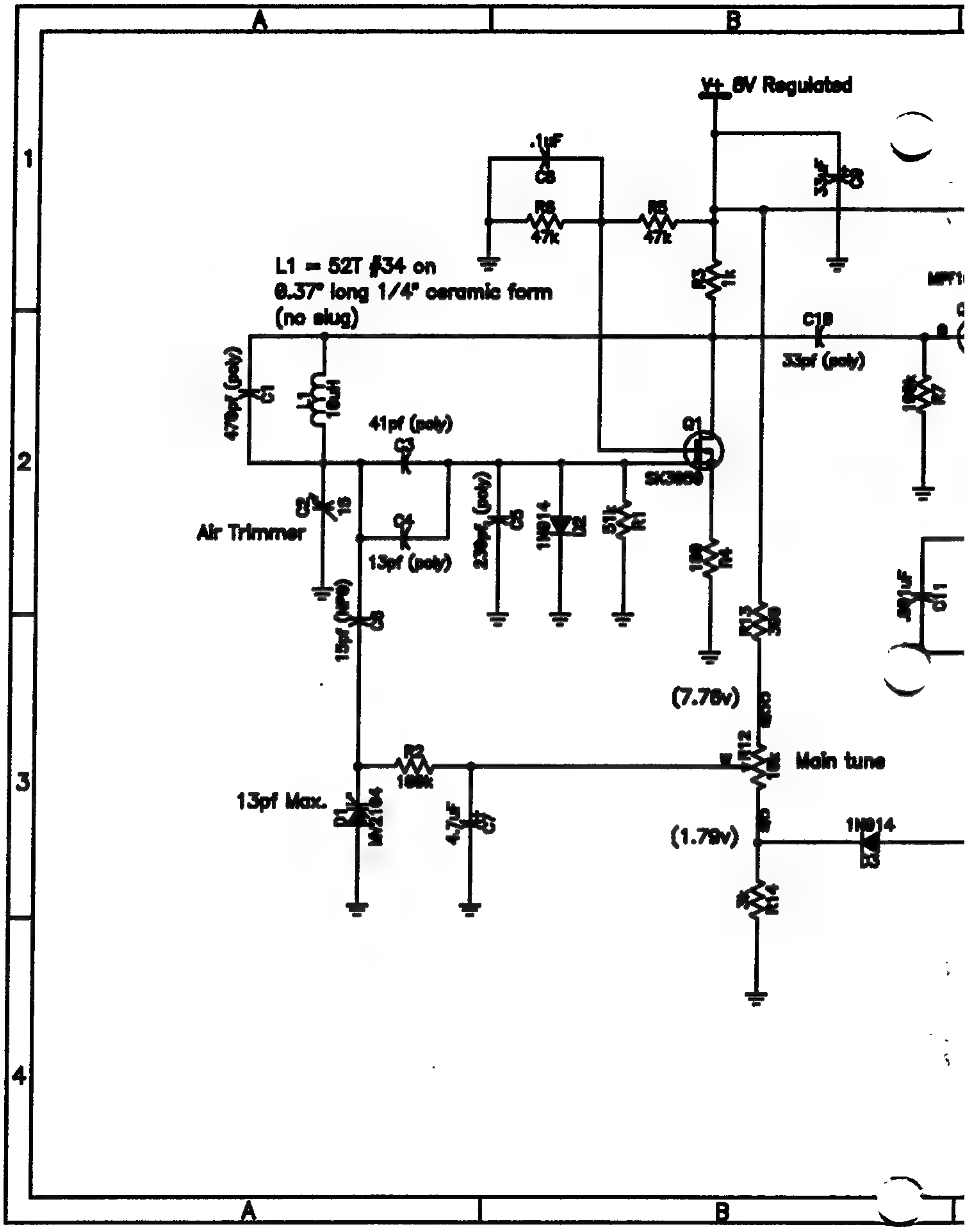


C
D
1
2
3
4
RX
RF IN
RECEIVER
AUDIO
VFO IN
+12v RCV
+5V RCV
GND
+12V
GND
OUT
+12V KEYED TX
AUDIO OUT
J2
COAX
TO RX
_VFO
+5V
+12V RCV
+5V RCV
+12V
+5V
C1
.01uF
Title
Tranceiver Chassis Wiring
Size
B
Number
Designed by K6BSU
Rev
Date
4/25/95
Drawn by WA6HHQ
Filename
Sheet of

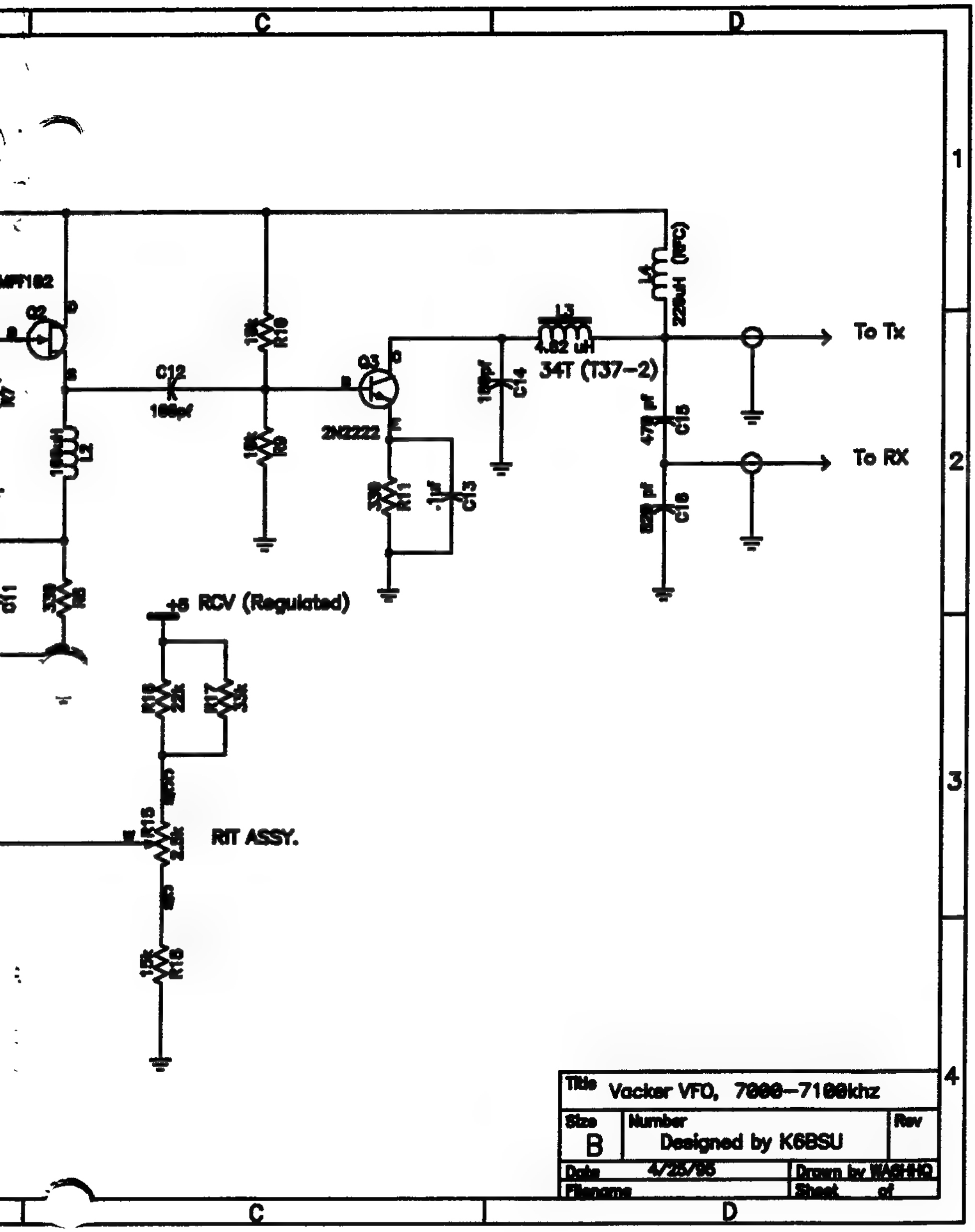


A
B
1
2
3
4
+12v XMT (400ma)
R8
10k
2N2907
Key In
R7
2.2k
Keying Transistor
Q2
C11
+12v Keyed (Out)
C5
0.1uF
24T, T37-2
Driver
VFO IN
J1
C1
22T
7T
T37-2
R3
270
C3
.01uF
Q1
2N3053
(30ma)
C6
1000pF
1N914
R10
10k
R11
1k

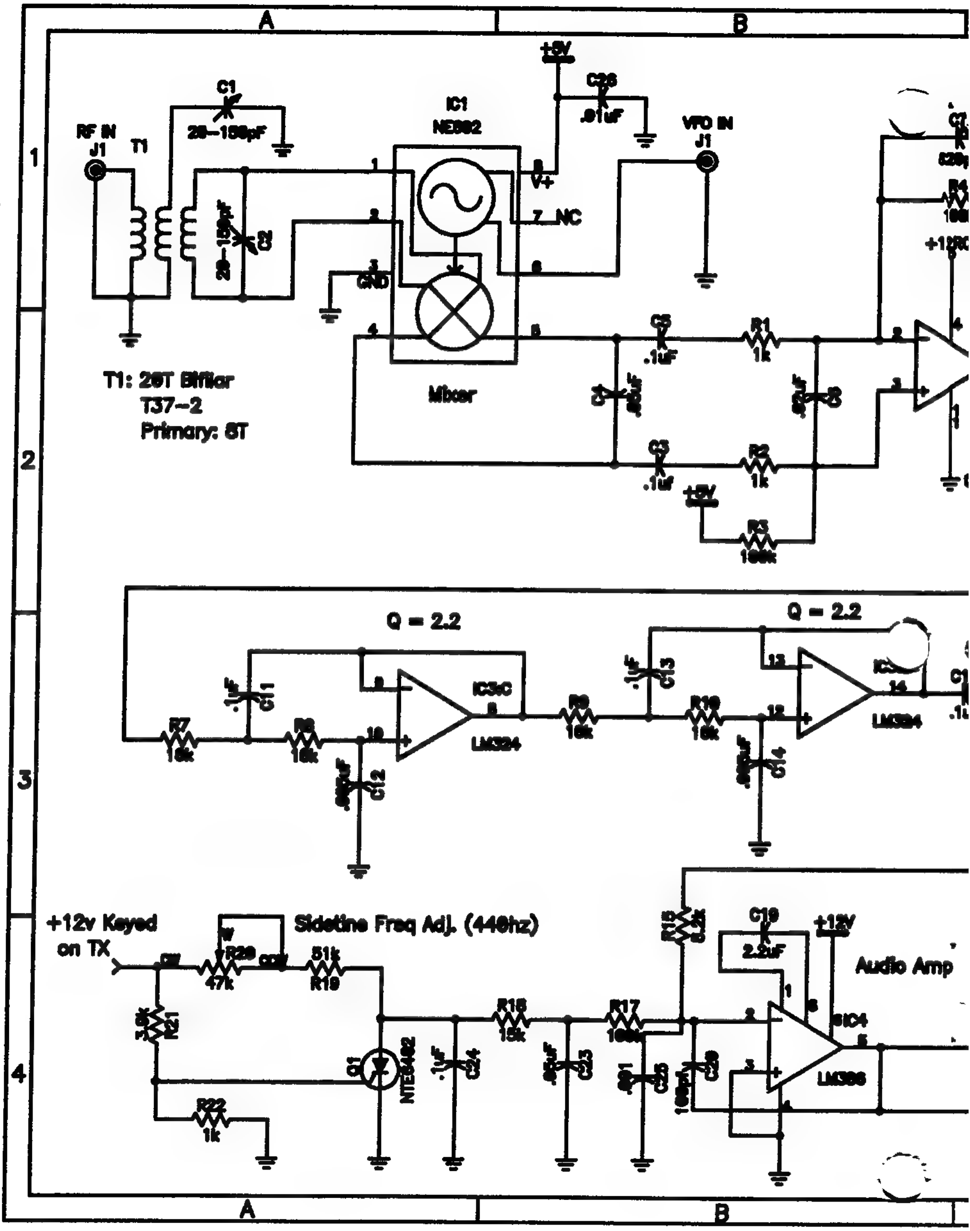

C
D
1
2
3
4
C7
R4
+12RCV
IC2:A
TL082
40 dB Amp
GND
C8
.1uF
Buffer
IC3:A
LM324
R5
7.2k
R6
7.2k
Q = 1.0
IC3:B
LM324
C10
(IC3B, C, D = 440hz LPF)
C16
C15
.1uF
R11
15k
R12
15 dB Amp
+6V
R13
15k
IC2:B
TL082
C17
.1uF
Coax
10k (Audio)
Audio Gain
R14
C18
C22
22uF
Audio Out
R16
10
C21
.1uF
Title 40 Meter Direct Conversion RX
Size B
Number
Designed by K6BSU
Rev
Date 4/25/95
Drawn by WA6HHQ
Filename
Sheet of

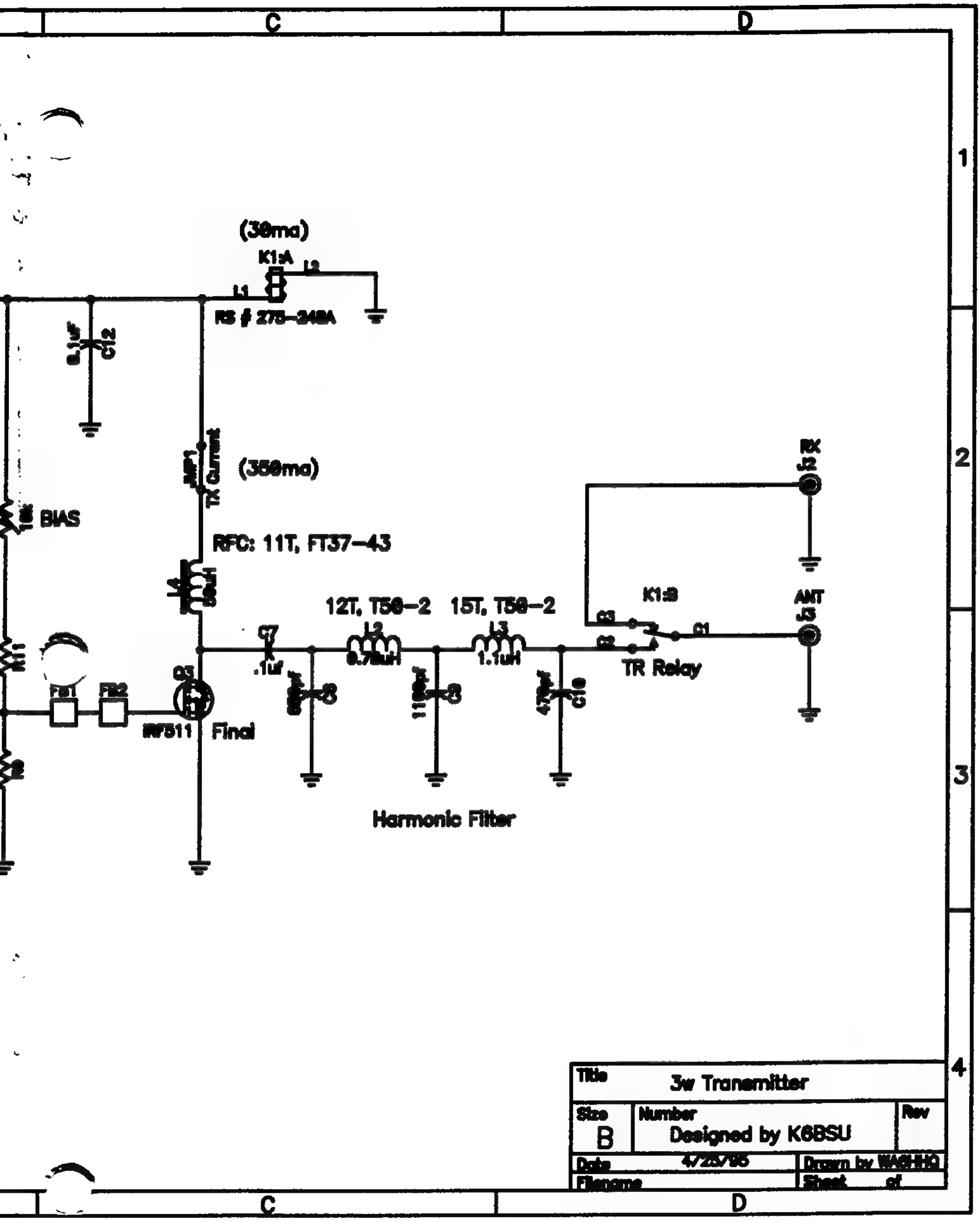


V+ 8V Regulated
L1 = 52T #34 on
0.37" long 1/4" ceramic form
(no slug)
41pf (poly)
13pf (poly)
33pf (poly)
Air Trimmer
13pf Max.
Main tune
(7.76v)
(1.79v)
1N914

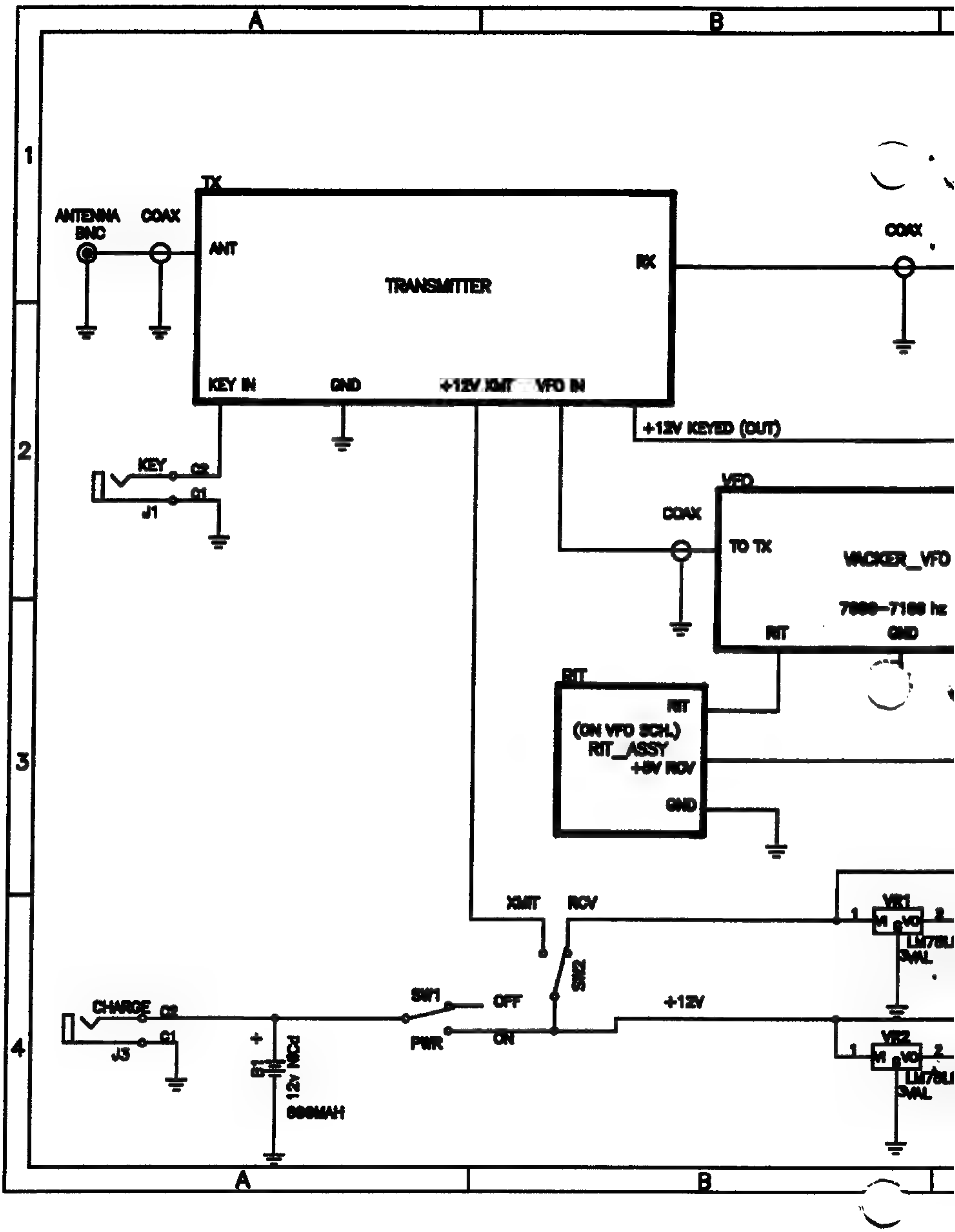


C
D
1
2
3
4
MPF102
Q2
C12
100pf
Q3
2N2222
L3
4.82 uH
34T (T37-2)
To Tx
To RX
+5 RCV (Regulated)
RIT ASSY.
Title Vacker VFO, 7000-7100khz
Size
B
Number
Designed by K6BSU
Rev
Date 4/25/95
Drawn by WA6HHQ
Filename
Sheet of


A
B
1
2
3
4
RF IN
J1
T1
C1
25-150pF
IC1
NE602
+5V
C26
.01uF
VFO IN
J1
V+
7 NC
GND
Mixer
T1: 26T Bifilar
T37-2
Primary: 8T
C5
.1uF
R1
1k
C3
.1uF
R2
1k
+5V
R3
100k
Q = 2.2
IC3C
LM324
R7
15k
R8
15k
R9
15k
R10
15k
C12
C14
LM324
+12v Keyed
on TX
Sidetone Freq Adj. (446hz)
R20
47k
51k
R19
R21
R22
1k
Q1
NTE5462
C24
C23
R18
15k
R17
C25
C19
2.2uF
+12V
Audio Amp
IC4
LM386
R15



(30ma)
K1:A
RS # 275-248A
C12
(350ma)
TX Current
BIAS
RFC: 11T, FT37-43
12T, T50-2
15T, T50-2
C7
.1uf
L2
L3
1.1uH
K1:B
TR Relay
RX
J2
ANT
J3
FB1
FB2
IRF511
Final
Harmonic Filter
Title
3w Transmitter
Size
B
Number
Designed by K6BSU
Rev
Date
Drawn by
Filename
Sheet
of


A
B
1
2
3
4
TX
ANTENNA BNC
COAX
ANT
TRANSMITTER
RX
KEY IN
GND
+12V XMT
VFO IN
+12V KEYED (OUT)
KEY
J1
VFO
COAX
TO TX
WACKER_VFO
RIT
GND
RIT
(ON VFO SCH.)
RIT_ASSY
+8V RCV
XMIT
RCV
SW2
SW1
OFF
PWR
ON
+12V
CHARGE
J3
12v NiCd
VR1
VR2
LM78L

some of my previous home-brew projects, this one started with a list of essential design criteria. The fact that the finished product actually met all my design criteria made it really "Special".

This transceiver packs a lot of QRP performance in a small and inexpensive home-brew project. The final design reflects the following criteria, in approximate order of importance:

1. VFO controlled, with no perceptable drift after a short warmup.
2. Sensitive and low noise receiver.
3. At least 100 KHz bandspread on 40 Meter CW.
4. Receive RIT
5. Shaped transmitter keying and built-in sidetone.
6. 3 to 5 Watts RF output
7. Modular construction for ease of trouble shooting and modification.

Before discussing the desired design criteria, let me list some features often found in other QRP transceivers, which I did not want to include:

1. QSK
2. Receiver RF gain control and AGC.
3. Xtal filter IF strip, air variable tuning capacitors, diode mixers, and other expensive or hard to find parts.

QSK is a feature of virtually all of the 100 Watt transceivers from the Orient. But not many CW operators use it. I make a point never to break in on a station I'm working until it is turned over to me. The station has something to say to me, so I extend the courtesy of listening instead of butting in. AGC action is annoying on CW. It is impossible to adjust the AGC time constant to match the wide range of code speeds, so gaps between words or pauses will allow the AGC to increase receiver gain, along with background noise. So I let the receiver run wide open all the time and use the AF gain control to provide a comfortable audio level.

CIRCUIT DESCRIPTION

The 73 Special contains three subassemblies, which may be built and tested individually. The subassemblies are: the Vackar VFO, the receiver, and the transmitter. Each unit is connectorized for easy removal and modification without soldering wires.

VACKAR VFO: The crown jewel of the 73 special is the Vackar VFO. My experience has shown that this circuit is more stable than either the Colpitts or Clapp. I have experimented with the Vackar VFO since 1978, and I have published two articles on this circuit in QST and CQ magazines. I have built Vackar VFOs at 4 MHz that exhibit less than 5 Hz long term drift. This one drifts a little more than that because of the temperature effects of the VVC tuning diode, but I think it is still superior to any other circuit. The 73 Special VFO operates from 7000 to 7100 KHz and it feeds both the receiver and transmitter without additional frequency conversion. A two stage buffer amplikfier isolates the Vackar oscillator from both receiver and transmitter, so the VFO frequency is not affected by receiver tuning, transmitter keying or antenna tuner effects. A pi output filter removes harmonics and this filter also performs signal splitting to supply the NE602 receive mixer with 200 mv and the transmitter with full power.

RECEIVER: Direct-conversion receivers always seem to get a bum rap. Even I was skeptical until I recently owned a Heath HW-8 QRP rig. I was impressed by its superb weak signal reception and by its sharply tuned bandpass audio filter. Finally, the absence of expensive or hard to align Xtal IF filters made the D-C receiver seem very attractive. The only shortcoming of a D-C receiver is its poor RF selectivity. So if the ham next door fires up on QRO you are out of luck. (I do happen to live next to another ham, but he doesn't operate much).

There is only one tuned circuit in the receiver! Well, it is actually double-tuned for a full 100 KHz coverage on 40 Meters. The popular NE602 double-balanced mixer IC is a good choice as the RF stage/mixer. It is simple, provides about 14 dB conversion gain, and is readily available for about $2. VFO injection should be about 200 mv R.M.S. at the signal frequency of 7000 to 7100 KHz.

The NE602 has a differential output, so maximum gain is realized by using both outputs of the NE602 into 1/2 of a TL082 dual op amp (Radio Shack). Simple R-C filtering permits only audio recovery, while the op amp gives 40 dB of audio gain.

IC3 is an op amp used as a 3-stage low pass audio filter with peaking at 440 Hz. Since the audio filter has nearly DC response, one can zero-beat an incoming signal (with RIT off). Peaking at 440 Hz. in the filter allows signals to "pop" in and out of the audio passband so that signals close close together are easily separated.

The remainder of the audio gain is provided by the other half of op amp IC2, and the LM386 audio power output IC easily drives a speaker with enough volume to let me copy from another room while I'm doing other things.

During Transmit, the entire receiver string is turned off by removing DC power, except that the audio power stage is always on. Then keyed 12V operates a Programmable Unijunction Transistor (PUT) audio oscillator which is coupled to the audio power stage to provide sidetone (also at 440 Hz). Many of the popular home-brew QRP rigs or "kit" rigs do not have sidetone, so that operation with a simple straigt key is difficult without it.

RIT enables zero beat of an incoming signal, thus conserving bandwith on the often crowded 40 Meter band. The RIT is configured so that maximum CCW rotation of the RIT control turns it completely off. Rotating the RIT control CW raises the receive frequency to about 1 KHz higher than the transmit frequency. The RIT is disabled on Transmit, so the transmit frequency then becomes the same as the previous zero beat frequency. No guessing about frequency offset here! It is automatic.

TRANSMITTER: The transmitter uses an inexpensive VMOSFET IRF 510 or IRF 511 output transistor from Radio Shack. DC input power to the stage is adjusted to 4.2 Watts with an RF output of 3 Watts. The VMOSFET is easy to drive, so only a simple Class A buffer stage is required between the VFO and the power amplifier. The Class A buffer is the only keyed stage, but RF leak-through is not detectable. A PNP keying transistor permits independent shaping of the keying waveform. An R-C network at its base terminal gives the desired waveshape, and it will respond to changes in R-C time constant, if different keying characteristics are desired.

The VMOSFET transistor gate has a threshold of +2 to +4 volts. So that at zero bias, only the positive RF peaks of the Class A driver output will cause conduction. This is equivalent to Class C operation. The conduction angle can be increased by providing some external bias to the VMOSFET. R10 does this, and this potentiometer is therefore used to adjust output power.

Various diode antenna switching schemes were tried, but all of them caused attenuation of the received signals. Nothing works quite as well as a good old relay. So this was used, even at the expense of an additional 30 ma of battery current drain.

CONSTRUCTION: The most practical starting point is to find a suitable cabinet and a small enclosure for the VFO. Then the receiver and transmitter circuit boards can be made in any shape that will fit the available space.

PC boards are a lot of extra work, and I can never seem to get them right the first time. So, I always start with single or double sided copper clad board material cut to shape as required. I first make a sketch of parts placement and then transfer all the hole locations to the smooth copper clad board material. Then all holes are drilled, and those which are not to be grounded are run through again with a pad cutter to remove about 3/

32" diameter copper from around the component lead holes.

Next, all components are placed on the drilled board so that the leads exit through the bottom of the board. I use "Zap" CYA instant adhesive to secure all parts. All leads are then cut to about 1/8" and the interconnection is done using 30 ga. Kynar insulated wire wrap wire. Those component leads to be grounded are simply soldered to the copper sheet. This construction technique takes a little extra work with a 25 Watt soldering iron. But it really saves time up front, because virtually no planning is required for parts placement, and no space allocation is needed for P-C traces. This technique also permits wiring changes and component changes without making a big mess of the circuit board.

Each subassembly is connectorized to the chassis wiring harness, and RF connections are made using RCA phono jacks and plugs. Miniature RG174 coax cable works well with these RCA phono plugs.

CALIBRATION: Only a few easy circuit adjustments are required and no special component selection is necessary. A calibrated station receiver or a frequency counter and a VOM are all the test equipment necessary to get the 73 Special on the air.

First, adjust the Vackar VFO to cover the desired 100 KHz portion of the 40 meter band with RIT control turned off (CCW). Turning the RIT potentiometer fully CW should cause the VFO to increase in frequency by about 1 KHz.

The two receiver tuning capacitors are stagger-tuned. Peak one of them about 1/3 the way up from the lower edge of the band, and peak the other one about 2/3 the way up.

Connect a dummy load to the transmitter and prepare to monitor the VMOSFET RF power stage current with a DC ammeter (connecting into the jumper shown on the schematic diagram). Key the transmitter and peak the two trimmer capacitors for maximum PA stage current at mid-band, or stagger them as was done for the receiver for an even power output across the band. R10 is used to set the key-down PA current to about 350 ma. At this point, a wattmeter should indicate about 3 Watts into a 50 ohm load.

The transmitter will easily produce 10 Watts output with a 15 volt power supply and with R10 set for maximum bias. Of course, this would not be be QRP, but 5 Watts output can be obtained with an extra NiCd cell in the battery pack. I chose 3 Watts output for a reasonable operating time from my built-in battery.

PARTS SOURCES

Dan's Small Parts
1935 So. 3rd West #1
Missoula, MT 59801 (ask for 6 page catalog)
1/4" dia. ceramic coil form (Millen)
RG174 coax
RF chokes
NE602AN mixer IC
MV2104 VVC
78L05 and 78L08 voltage regulators
1N5258 Zener diode.
Amidon toroid cores and ferrite beads
mica trim caps, NPO ceramic and poly caps

Radio Shack
IRF510 or IRF511 VMOSFET
2N3053, MPF102, 2N2222, etc.
op amp ICs
fixed resistors & pots
most ceramic capacitors
hardware and wire
RCA phono jacks and plugs
connectors

A Simple Noise Blanker for NE602-Based Receivers

by Wayne Burdick, N6KR
1432 6th Ave.
Belmont, CA 94002
wayne@interval.com

I just realized—after six months—that I have a very high noise level at my new QTH during the day. I guess I'm spending too much time building radios to notice things like this. Anyway, I was working on a 20M SSB receiver, heard the horrible noise, and decided to do something about it.

What I needed was a noise blanker: a circuit that detects large, short-duration noise spikes and suppresses them before they get to the crystal filter. Every commercial radio has one, but you rarely see one in a home-brew design. The noise blanker I came up with reduces that loud, buzzy line noise that comes from power poles and the like.

I could spend a couple more months refining the circuit, but I decided that it was working well enough that I had to let people with serious noise problems start using it right away. It's sort of like when new medicines are being studied; one group gets a placebo, the other gets the real thing. The group getting the real thing suddenly gets healthier, while the placebo group starts dying off. Out of compassion, I have suspended the study.

This noiseblanker is quite simple and won't work in all cases—just on very repetitive line noise. It won't do anything for atmospheric noise: for that you need "diversity receive," another thing you don't see very often in homebrew rigs!

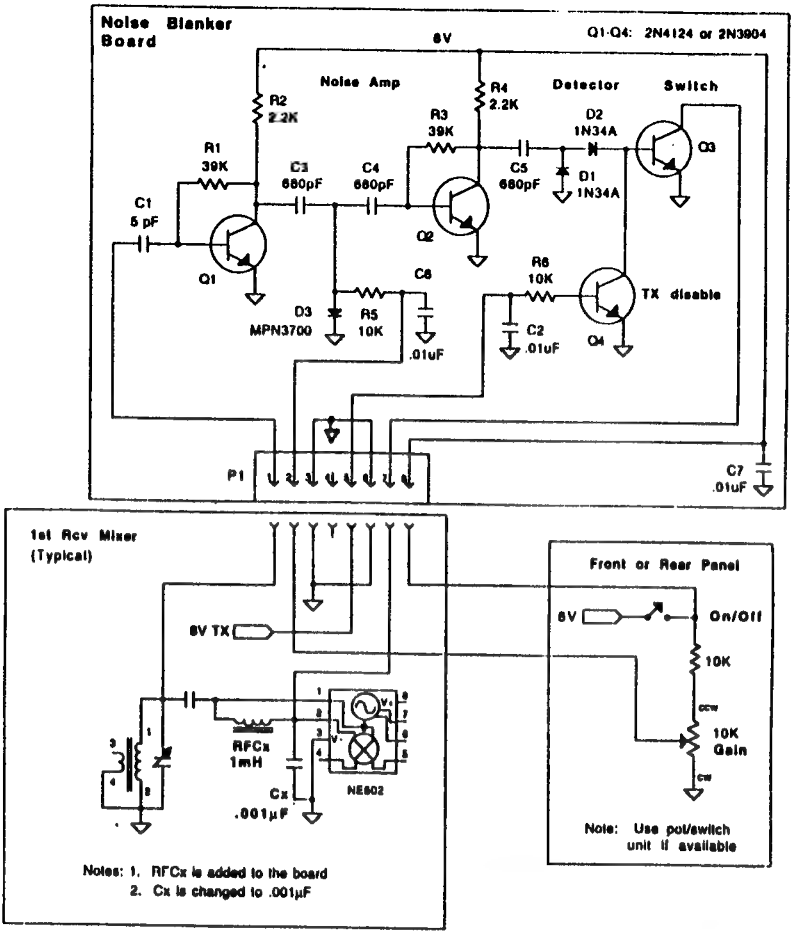
The Circuit

The schematic (fig. 1) is shown in four parts: (1) the noise blanker itself; (2) a typical NE602-based receiver front end, in this case the Sierra's; (3) a small box showing the controls that you'll need to add to the front or rear panel of the rig; and (4) a line noise simulator that I used to test the noise blanker (this circuit really cranks out some noise, and it sounds just like the real thing).

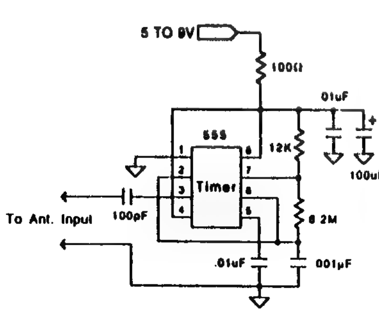
The noise blanker taps off the input tuned circuit of the rig via C1. This signal is amplified by Q1 and Q2. The noise pulses are detected by D1 and D2 and applied directly to the base of Q3, which then shuts off the first receive mixer for a short period to mute each noise pulse. D3 is a PIN diode, and is used to vary the gain of the first amplifier stage by way of the panel-mounted gain control. I used a PIN diode attenuator so that the GAIN control could be located anywhere. Q4 disables Q3 during transmit, which is important if the rig uses direct transmit monitoring. On the Sierra, for example, if you don't have Q4, then when you transmit, you can't hear the monitor tone.

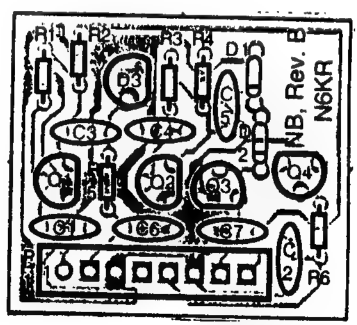
Notice that there are two very important changes to the first receive mixer to accommodate the noise blanker. First, the bypass cap from pin 2 to ground has been changed to .001 rather than the usual .01 or .05. This is necessary because Q3 has to be able to kick in very quickly to mute the noise pulse. The larger the cap here, the longer it takes for Q3 to act on the pulse, and once the pulse gets past the first receive mixer you can't do anything with it. Noise city. The smaller cap won't reduce receiver sensitivity.

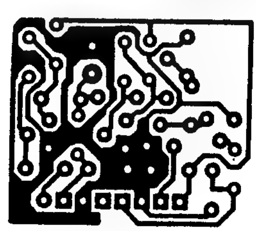
The second important change is the addition of the RF choke from pin 1 to pin 2 of the '602. This is needed to make sure that the mute signal is "common-mode," thatis, it must appear on both differential inputs to the mixer so that it gets canceled and doesn't appear at the mixer output. If your receiver circuit has a complete D-C path from pin 1 to pin 2 already (usually via a toroid core), you can eliminate the RF choke.



Line Noise Simulator







Construction

The blanker MUST be built on a small board and tucked in close to the receive mixer. This is because the leads between the receive mixer and the noise amplifier have to be very short: if they're too long, they'll pick up all kinds of stuff you don't want them to, and reduce the effectiveness of the circuit. The circuit itself should be built with short leads, too. Dead-bug will work just fine, but pack 'em in close and keep everything close to the ground plane.

The PCB outline is shown in fig. 2. This is 1:1. Note that all resistors are 1/8 watt, although you could use 1/4 watt resistors if you stand them up on end. All capacitors should have 0.25" lead spacing or less.

Wilderness Radio will probably be selling a noise blanker PC board for practically nothing. The board will be a ridiculous 1x1", making it easy to fit into any rig. Check with Bob Dyer (415-494-3806).

You'll notice that a connector, P1, is shown on the blanker board. This connector will, someday, mate with a socket on the next revision of the Sierra PC board, allowing the noise blanker to be simply plugged in. In the mean time, P1 will be just a row of pads on the board, which you'll have to hard-wire to the rig. The leads labeled P1 pins 1, 3, and 7 should be VERY short (no more than 3/4").

Component values are not critical; you could probably vary the caps +/- 50% and have things still work. I'd stick with the R values shown, +/- 20%. High-beta transistors are needed at Q1 and Q2. You must use germanium diodes at D1 and D2, and a PIN diode at D3. The MPN3700 works great at D3. The MPN3404 might work, and the 1N4007 definitely does work but you have to change R5 to 1.8K and connect the gain pot directly to 8 volts with no series resistor. An MPN3700 will come with the PC board.

I used a 10K pot with a built-in switch to control the blanker, although you could use a separate pot and switch if you have panel space for it. The pot could be 5K or 10K. I used an audio taper pot, but linear taper will be better.

Operation

Using the blanker is simple: just turn it ON and adjust the GAIN control until the noise just disappears. The blanker adds about 6 to 7 milliamps of current drain, so you'll want to leave it OFF when it isn't needed.

Because the noise amplifier loads the input tuned circuit slightly, you'll have to repeak that tuned circuit. On the Sierra, you'll have to do this for each band module. This can be done with the blanker OFF.

Performance

When the power poles sing, this little noiseblanker makes the difference between hearing and not hearing. It works great on the Sierra and the NorCal 40, and should work on a variety of other simple receivers, too.

With SSB receiver designs, it is a must-have; SSB bandwidths make the noise seem worse that it is when using narrow CW filters.

That said, I can't kid you: it is a simple circuit and has a couple of limitations. Most important, the amplifier gain rolls off a bit as the frequency goes up. The gain is sufficient up through 15 meters on my Sierra, but I just bet someone is going to find out that the amp needs more oomph to handle their particular receiver and noise situation. Said individuals should play with the circuit and improve the gain. But not at the cost of stability, simplicity, or low current drain, I hope.

The second limitation is that on 40 meters and below the GAIN setting can be critical. This is because loud signals in the passband of the receiver, such as A.M. broadcast

stations or the guy down the street, can sometimes be nearly as loud as the noise pulses you're trying to mask.

If you turn the gain up too high, you'll find out exactly what I mean: the noise amplifier will become saturated with these large signals, Q3 will pass the signals on to the NE602, and you'll hear an assortment of garbage signals coming through your receiver. Don't do this! Back down the GAIN control if you start hearing new stuff that isn't supposed to be there.

By the way, even commercial noise blankers suffer from this to some degree, but they don't usually admit it. I hope this project helps you work the weak ones!
72, Wayne, N6KR

The Pixie 2: An Update

by Dave Joseph, WA6BOY
1873 Harris Ave.
San Jose, CA 95124

The Pixie 2 first appeared in the third issue of the NorCal QRPp Journal. Doug, KI6DS, recently asked me if I would write another article updating it, since the membership has grown so much and many of the new members have not seen the article.

The circuit first appeared in an issue of the G-QRP Club's "Sprat" and the first issue of QRPp. It was designed by RV3GM. I've modified the circuit's output and audio amplifier.

Although most of the QRP circuits today have evolved into using superhet receivers, a diversion back to direct conversion is not unusual... since QRP, after all, is a unique part of amateur radio and simplicity is certainly a part of it.

The Pixie 2 is a tiny rig, with a standard two transistor transmitter. It's a Colpitts oscillator, left running, and a keyed power amplifier. There is no external mixer used to feed the audio amplifier. Instead, the mixing is done at the final amplifier itself with the resulting audio taken off the emitter.

As you look at the audio amplifier you will certainly notice D1. It is an unorthodox approach, but it works. The diode can be left out but it helped to keep down the "crashes" during keying by shutting down the 386 chip. I'm no wizard at this... I just tried it and it seemed to work. I'm sure there's lots of you that have much better ways.

There's no RIT, a simple switch and cap in parallel, between the crystal will work as an offset though. You'll lose QSK but, here again lies the call for enhancement. The whole idea here was to make a tiny rig that worked, with LOTS of room for improvements, using a minimumb of parts.

Contacts spanning hundreds of miles are routine with this rig on 80 meters. Band changing is simply a matter of pi-network and crystal changing. If you build one, I'm sure you'll have fun with it. Construction can be by any method, perfboard, "ugly" and pc board. Complete parts kits are available for those of you who are interested. (1)
Construction:

You will need a low wattage soldering iron with a small tip, some rosin core solder, solder wick (for removing parts when you make mistakes), small wire cutters, needle nose pliers plus any additional tools you may wish to use. PLEASE PROTECT YOUR EYES WHILE CUTTING LEADS AND SOLDERING COMPONENTS! WARN OTHERS CLOSE BY.

Since all the components, except for U1, are mounted vertically, it's best to start at one end of the board and work to the other. No particular starting point is necessary. Take your time, enjoy the assembly. Your transceiver will be finished sooner than you think.

There's no coils to wind, no alignment either. This is definitely a FUN project.

Note: There is one component that will be mounted on the underside of the board if you build it with the pc board. This is the 1K resistor in the kit. Refer to the drawing on the parts layout for it's location.

Before you get started, note the following parts MUST be installed only one way: The 10uF electrolytic caps, D1 - the diode, the two transistors, and finally, U1 the audio amp chip. Make sure you mount these components exactly as the parts layout shows you to. If you mount any of these the wrong way, your transceiver will not work and you'll probably destroy the part. The only exception is C11, but it is best to install it as shown.

Mount all of the parts, again, starting from one end of the board. Carefully check to see you have the correct part before installing it in it's location. Refer to the parts layout drawing. Double check before inserting the part. This will avoid problems in getting your rig on the air. Install the 1K resistor last. This resistor is R5, and is tack soldered between the 9 Volt pad and the POSITIVE terminal of C10. Dress the leads of this resistor so that they "fly" off the board. You might want to put some sleeving over the leads, or, some electrical tape underneath to be sure they don't short to the board. R5 is shown in dotted lines on the layout.

You will need the following additional items (not supplied in the kit):

2 - RCA jacks, or 3.5 mm jacks. (For Key and Antenna).

1 - 3.5 mono or stereo jack, depending on your headphones.

1 - short piece of RG- 174 For Antenna Connection.

1 - Crystal socket or pair of mini-alligator clips.

This transceiver does not have RIT (receiver offset). It is possible to work other stations, if you are close to their frequency. Even if the received signal is off frequency, give them a call. A simple RIT circuit using a mini-toggle switch and capacitor, hooked up in parallel, and placed in the line between the crystal and ground works well. You won't have full break-in, but it works.

Remember, all that's needed to change bands on this rig is change L3 and the crystal, and you have a rig for another band!! You can use "walkman" style headphones, with a mono adapter. There is even enough audio power to drive a speaker. It's not very loud but you can hear easily in a quiet room ... neat!

This rig has been packaged in a 35 mm film can, a Tic-Tac box, Sucrets box (easy), just to name a few. The enclosure is up to you. One just big enough to hold the rig and the 9 Volt battery will give you a tiny self contained unit.

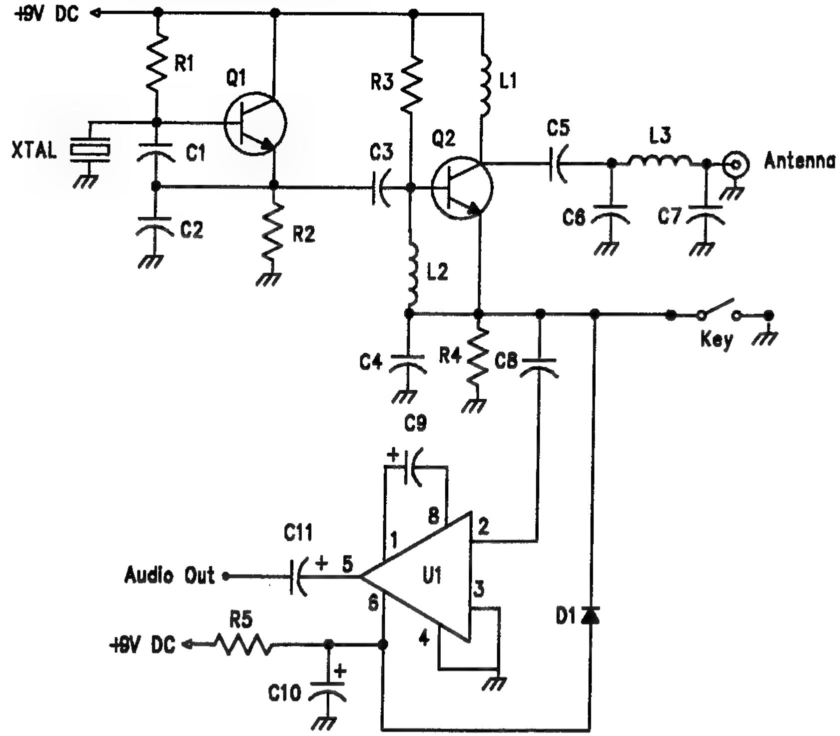
Many contacts using a simple end fed quarter wave wire, worked against a good ground, have been made with this rig. Most of them have been over hundreds of miles away. The transmit signal is very clean, with no key clicks since the oscillator is always running. Just listen to it! Power output is in the 200 to 300 milliwatt range. You'll be amazed what happens at this power level with a decent antenna.

This is a "bare-bones" rig. Use your ingenuity or, enlist the help of an experienced ham to help enhance the operation of your rig. Refer to QRP articles, like those in QRPp, SPRAT, ARCI and others devoted to QRP operating. If you're not an experienced builder, this kit was designed especially for you. If you've been building circuits,, it's hoped you'll have fun with this little rig and/or help a beginner get started in the wonderful world of QRP.

If you come up with mods for the rig, publish them in QRP. Send Doug reports on your experience building and operating it. There are surplus crystals available for less than a dollar for 3.579MHz and 3.686MHz. For that price, buy one, solder it in and don't worry about changing frequencies.

Enjoy, 72, Dave, WA6BOY

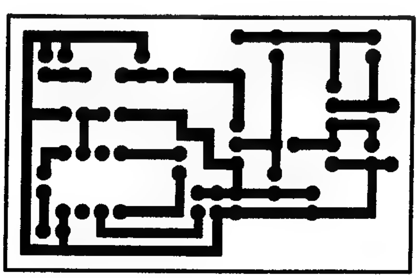
(1) Parts kits for the Pixie 2 are available from: HSC Electronics, 3500 Ryder St., Santa Clara, CA 95051. The cost is $9.95 + $2.00 shipping and handling for the pc board and all board mounted components except the crytal. Chokes will be provided for both 40 and 80 meters. Phone 1-800-4HALTED.



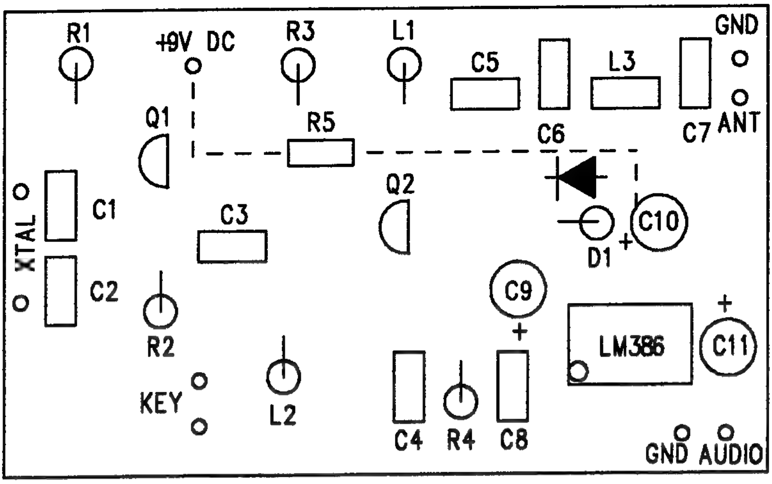
Parts List

C1,2	100pF	C9,10,11	10uF/25V Elec	R1	47K
C3	82pF	D1	1N914	R2	1.5K
C4	.05uF	L1	15 - 22 uH Choke	R3	33K
C5	.01uF	L2	100 uH Choke	R4	10K
C6,7	820pF	L3	40M - 1uH	R5	1K
C8	0.1uF		80M - 2.2uH	U1	LM386

Fig. 1 Pixie 2 Schematic



PC Board Foil Side



Parts Layout Pixie 2

Improved Selectivity for the Deluxe QRP Station

by Jim Pepper, W6QIF
44 El Camino Moraga
Orinda, CA 94563

[The original article appeared in QRPp, in Volume II, Number 2, June 1994]

After using the QRP receiver in the Deluxe QRP Station, I found that I seldom used the null circuit. It was especially difficult to use in trying to null out a cw signal. Many years ago I ran across an article in Ham Radio (December 1981) on an active filter using a Sallan-and Key circuit that gave more than 40 dB per decade roll off. It was similar to the null circuit so I decided to convert over to this circuit to see if I could improve the selectivity. One of the reasons people don't like the Direct Conversion receiver is because they claim it doesn't have the selectivity of a superhet especially one with a crystal filter. I wanted to see if I could overcome this draw back.

Before making the mod, I used a SPICE program by GEOBAN to get the response I wanted. See the curve in figure 1. I also measured the response of the receiver with an audio oscillator and scope before and after the mod.* They compared quite favorably with these curves. I also asked John Pratt (N1UA) to make the change and he reported similar results. In checking the receiver before the change, he could hear a signal about 4.5kHz away from the peak and after only 1 kHz. I also found the same on my receiver. It definitely is worth the change.

To make the change requires some trace cutting but in all the change is not that great. The attached drawings should be self explanatory. The two resistors by IC3 can be jumpered on the trace side leaving the resistors in. Remove the 1uF tantalum capacitor. Next to IC2 replace the 47K resistor with a 68K. Remove the 10K and replace it with a 0.1uF capacitor.

On the trace side, two cuts are required. One on IC2 as shown and one on IC3. IC3 has three jumpers. Two as I have said before and the third from the 510pF cap to pins 6/7. On IC2, add a 12K resistor across the area where you made the cut. And then add a series circuit composed of a 47K resistor and a 0.1 cap going from the two traces shown.

That is it. The null control is no longer effective but it remains in. Set it to the full clockwise position.

Before you make any changes, try to determine the bad width of the present circuit. Tune some loud signals a the same time looking at the counter frequency if available. Try to determine how far out you can go and no longer hear the signal. Later with the mod, do the same thing.

*(To measure the response, I removed the NE602 and connected a wire from pin 5 of IC2 to the 5V source. I connected an audio signal generator to pin 6 through a capacitor. (.1uF). Then I took readings from 400 Hz up to 4 kHz. I connected my scope to the output jack with the speaker still in. I set the audio gain to about 1/3 and raised the generator output to give one volt PP on the scope at the peak point (approximately 800 Hz.).)
Plot the readings against the frequency.

The output should not show any flattening at this level. It would be best, if you desire to go this method, to take the readings before you make the change. The difference tin the shape of the curves should show the improvement. When done with the mod change, you can go directly to the "proof in the pudding" and check thereceiver response again.

Note: The magical Filter (73 Magazine, Nov. 1983 and QRPp, Vol. I, #3, December 1993) uses the same circuit. It could also be modified to give similar results. 72, Jim Pepper, W6QIF

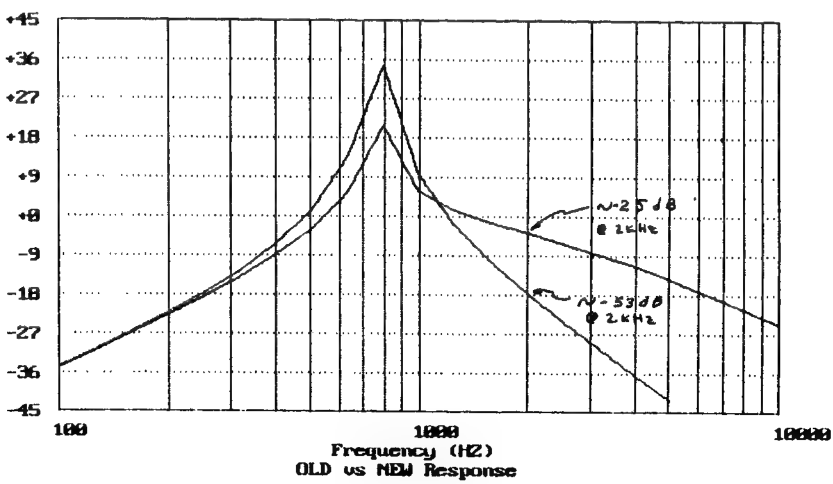


Figure 1

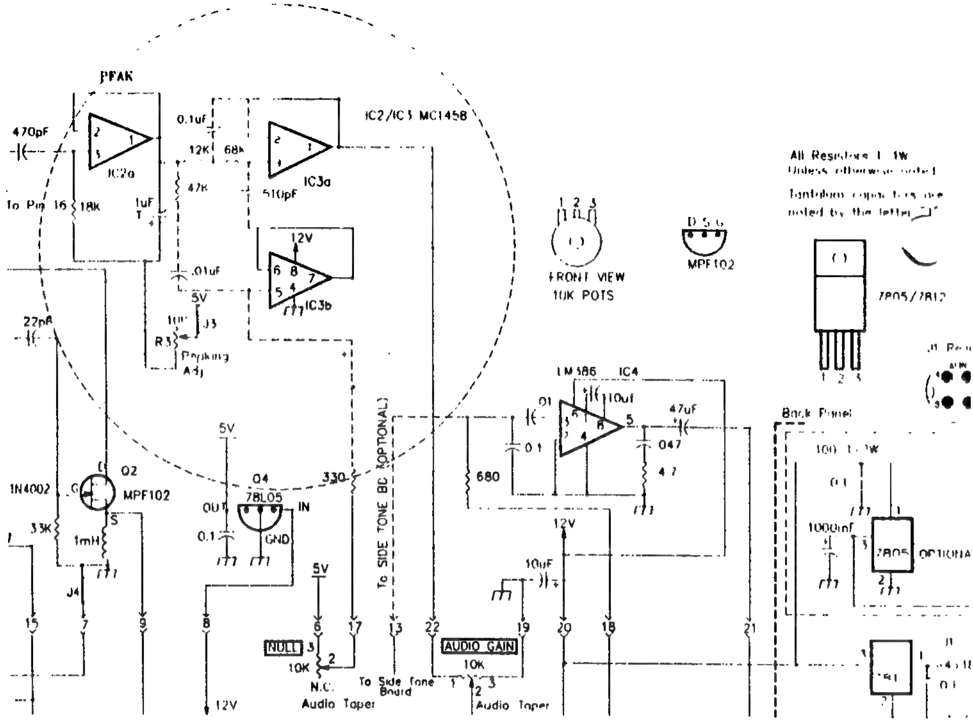


Figure 2

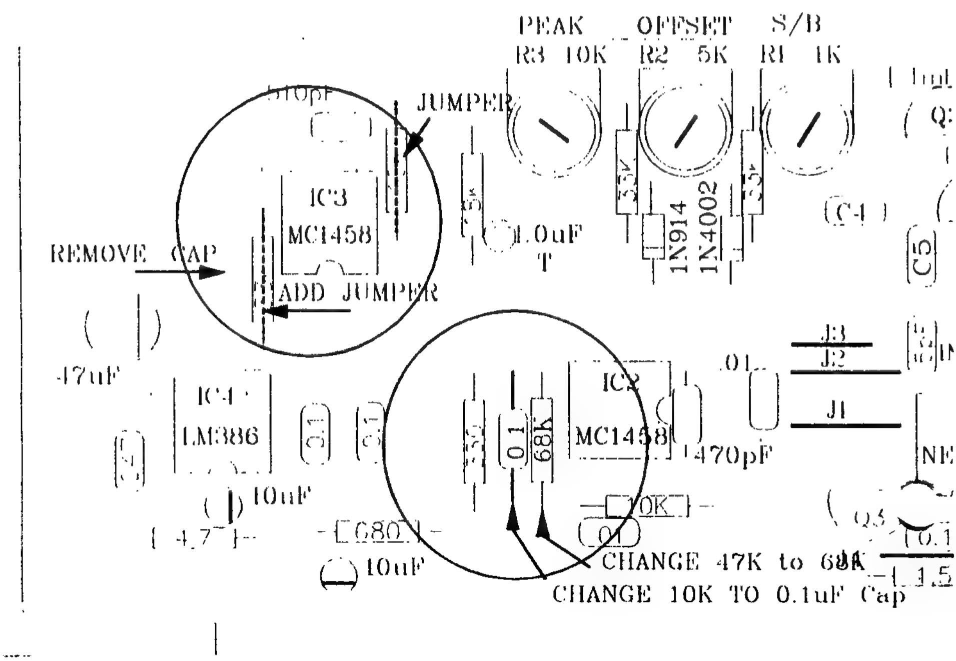


Figure 3

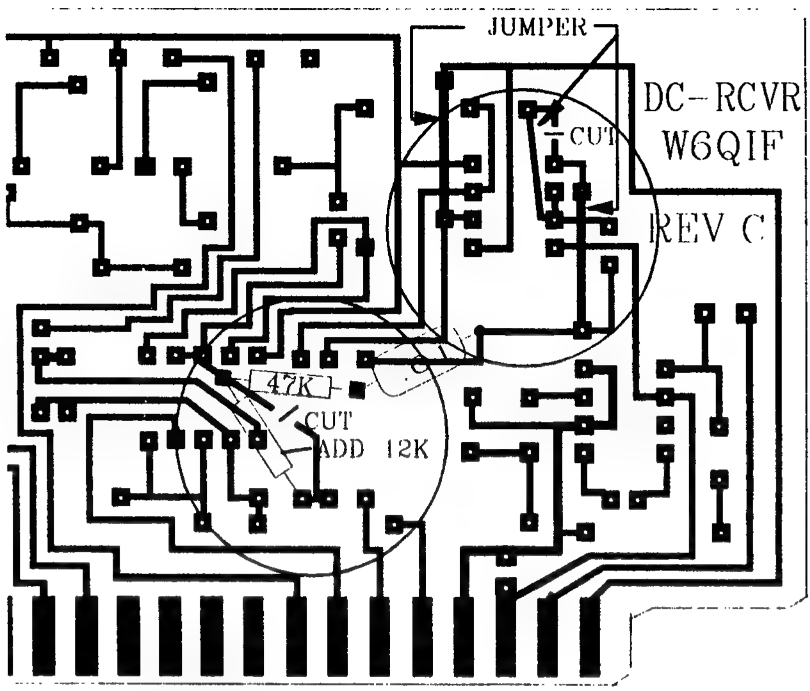


Figure 4

Warning: Notorious QRP Pack Rat at Large

by Jim Cates, WA6GER
3241 Eastwood Road
Sacramento, CA 95821

Was it Dr. Freud or mike Royko's Dr. I.M. Cookie who explained it to me this way: "Jim, you are a pack rat because you grew up during the THE GREAT DEPRESSION, and being deprived of toys during those formative years, it is only natural that now in your SECOND childhood, you have become what you are today, a hopeless pack rat." I protested that saving paper clips and rubber bands might be a minor quirk, but hardly qualifies as apersonality disorder. "Oh yeah?" exclaimed the good doctor, "who else would have an attic full of empty beer cans?"

Alas, alas, now exposed, I may as well confess to being an accumulator of a lot of things, but especially QRP stuff. I think this limiting is a step in the right direction, and may indicate some progress in coping with this pack rat malady. Oh, yes, I am into key paddles and wattmeters also, but that is a tale for another time.

Ok, so much for the problem; now for the solution. If I am to become the Hunt brothers of the QRP World, then to corner the markiet, I simply must have your help. Upon what dusty shelves lie these QRP goodies I seek? Including rigs, kits, accessories, books, magazines? You name it.

So what if I squander the family fortune in this madness? Can't cost any more than psychotherapy. and besides, I not only enjoy owning and fondly gazing at the QRP stuff I have managed to accumulate so far, but I also use it. I like to rotate rigs; it's like getting a new toy. and the books and magazines, oh what a poor memory I; can read them every month and each time like a new issue.

Oh, I won't even attempt to list the QRP treasures already adorning the shack. The list would be long, hence tacky. And would suggest bragadoccio.

Sick? I suppose so. But I prefer to look at it this way, anything worth doing is worth OVERDOING? Hi Hi. So, whatchagot and how much? Tnx 72/3 .. Jim/QRP

South Baldy Fire Lookout Tower (Idaho) Report - Summer 1994

by Al Schlottman, KL7CVP
2429 E. Soundview Dr.
Langley, WA 98260

I had one of those gut feelings that this was going to be a bad day. The huge thunderstorm that had pounded my north Idaho fire lookout tower all last night had finally moved on, but I knew it must have left danger lurking behind. And sure enough! Over there, on the far mountain ridge, a thin wisp of smoke was starting to curl up from the trees. It was small at the moment, but with the strong wind that was still blowing, I knew that it wouldn't be long before that bit of gray smoke turned into a raging inferno.

And that's exactly what was happening, even as I watched. My God, if the fire continued up the valley to its right, it would run right over the "WE ARE ALL SMILEY FACES" old folk's retirement home nestled up in that drainage . . . and not very far from the embryo fire at that. Or, if those hellish flames turned to the left instead, they would sweep right down into the "CHOCOLATE CHIP COOKIE" Girl Scout camp, also just a mile or two up that valley!

Oh, the horror of it all! All those poor souls, all that threatened humanity! I HAD to alert the Forest Ranger headquarters about the impending catastrophe. But how? Earlier, while I had been standing out on the catwalk, a bolt of lightning had zapped my Forest Service handheld radio clean out of my hand (naw, it didn't hurt.... only a slight tingling sensation), but the rig had been destroyed by its 80-foot fall to the rocks below. Thus I had no radio, no vehicle, and the next pack train wasn't due to come up for two months. I was totally without communications.

But, wait! There was my ever reliable NorCal 40 QRP rig just sitting there on the table. Swiftly I disconnected my wife's hair curler and waffle iron from my battery pack power supply, hooked up the NorCal, and turned it on. But . . . the band was stone cold dead! Not a signal to be heard anywhere across the rig's vast tuning range. But, hold on! There was one faint signal, a VK7 in Tasmania calling CQ. Three times I gave him a call but got no response (this was unheard of with my NorCal!). But then, after tweaking the antenna tuner a bit, I tried one more call and finally had the VK7 hooked! In frantic haste I explained the situation to him. (Luckily, I had majored in advanced Tasmanian while in grammar school). Minutes later the fellow was on the overseas telephone calling the White House, who called the Department of Agriculture, who called the U.S. forest Service, who called our Idaho Ranger station to report the raging fire that, unknown to them, was roaring across the high Idaho forests, soon to claim possibly hundreds of unsuspecting, innocent victims in its path.

But no!! We were in time! It seemed like only scant minutes after my frantic call to the Tasmanian when dozens of smoke jumpers rained down out of the sky, tanker planes started dropping hundreds of gallons of fire retardant on the worst of the flames, and ground fire fighters attacked the fire on all sides with bulldozers, shovels, and MRE's. And not long after that, the Chief Ranger came racing up the rough trail to the lookout tower to congratulate us and my NorCal 40 on a job well done.

Well, maybe that 's not EXACTLY the way it happened... except perhaps in my wild imagination or daydreams. Nevertheless, the old NorCal 40 certainly did help to keep me

in contact with the outside world down below, and it enabled me to make lots of great contacts from our lonesome tower high up in the mountains. (Having an antenna up at 6,000 feetprobably also helped?). In fact, I was even lucky enough to have a short QSO with a fellow by the name of Jim something or other. As I remember, his call was something like WA6GER. That particular QSO stuck in my mind, because the fellow made the far-fetched claim that he too had a nodding acquaintance with the NorCal 40! 72, Al, KL7CVP

Double-Tuned Tower Radiator

David D. Meacham, W6EMD
206 Frances Lane
Redwood City, CA 94062-2733
ddm@datatamers.com

Brian L. Wermager, K0EOU, urged me to report on my success in adapting his broadband, 80-meter-antenna design to a short tower and to publish my analysis of how it works (see his original article in April, 1986 QST and in recent ARRL Antenna Books). My version uses a 28-foot tower made of Rohn-25 sections with the following antennas mounted on a 13-foot-mast extension (2" OD steel pipe):

1) 2-meter Ringo on top of the mast (41-foot level).
2) 6-meter 5-element Cushcraft Yagi at the 39-foot level.
3) 2-meter 11-element Lunar Yagi at the 36-foot level.
4) Two stacked 432 MHz 16-element KLM Yagis centered at 33 feet.
5) A KLM KT-34A tribander at 30 feet.

My slanting top wire is connected at the 26-foot level and is 106 feet long. It is bent back toward the tower at the 8-foot level and continues horizontally for 40 feet 9 inches. I feed a single wire at the 8-foot level on the tower. This wire is 59 feet 11 inches long and is spaced 18 feet from the bend in the top wire at the far end. At the tower end the support point for the horizontal portion of the top wire is spaced 53 inches from the driven wire by means of a yardarm (to reduce capacitance between wires).

My analysis of the system follows:

1) The top wire, combined with the tower and Yagis, produces 3/4-wave resonance. The length is foreshortened by the capacitance-to-ground of the yagis on the mast. In my case the capacitance shortens the overall length by about 55 feet. The wire forces the tower to carry a heavy, nearly-constant current to ground, producing low-angle radiation. The current in the tower is that which occurs in the first 1/8-wavelength (or so) of a grounded monopole— essentially constant.

2) 8 feet of the tower, combined with the driven wire, produces 1/4-wave resonance.

3) There is an 8-foot piece of tower common to both resonant circuits. This provides some inductive mutual coupling. The capacitance between the wires, especially at the ends, produces more coupling because the ends of the wires are 180 degrees out of phase (opposite polarity). So the system really is a double-tuned circuit. This explains the excellent bandwidth, the shape of the SWR curve, and helps one to know what to prune.

4) Pruning and installation effects:

Parameter	Major Effect	Minor Effect
Feed height on tower.	Match.	Coupling (hump height at center response).
Spacing of wires at far end.	Coupling. (hump height)	Response at band edges.

Length of top wire.	Response at 3.5	Overall match.
Length of driven wire.	Response at 4.0	Overall match.
Tower height and what's on top.	Length of top wire.	Feed point.
Wire height above ground.	Resonant frequency. (lower if lower wire)	Driving impedance. (lower if lower wire)

The double-humped response of coupled, tuned circuits is inverted when you look at the SWR curve. So, one sees double dips with a hump in the center. The higher the coupling, the higher the hump. For background information on double-tuned circuits see Terman, Electronic and Radio Engineering, McGraw-Hill, 1955, Page 64, or Bowick, RF Circuit Design, Howard W. Sams, 1982, Page 37.

The reason I have so much spacing at the far ends is that the bent-back wire presents about double the area to the driven wire, hence double the capacitance. To bring this down I needed double the spacing.

Notice that the SWR is a bit high at the band edges. I think a second driven wire, as K0EOU has used, double-tunes the response of the quarter-wave portion, resulting in a triple-tuned system with greater bandwidth. I never operate at the band edges and I don't have room for another driven wire, which would have to be on the far side of the single wire in order to minimize the capacitance to the top wire.

The tower does most of the radiating. The currents in the wires largely cancel each other. So, most of the radiation is vertical. I use only three 8-foot ground rods at the bottom of the tower for grounding.

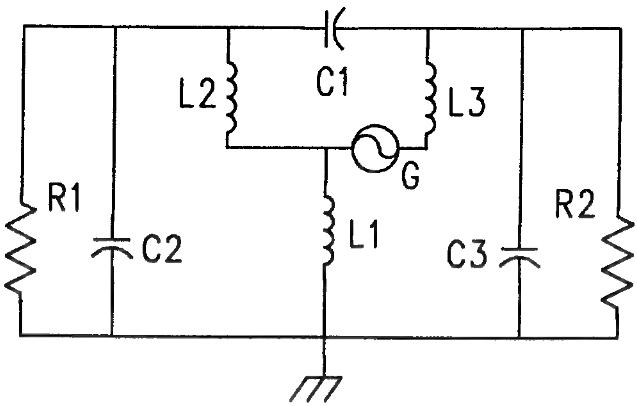
Many variations are possible. 160-meters on a 55-foot tower should work, as well as 40-meters on a short tower. Either wire can be bent in any reasonable configuration so long as each is resonant. The key is to provide the correct coupling capacitance between wires. The equivalent circuit is helpful to visualize coupling elements.

The plot of top-wire length vs tower height provides a good starting length. It assumes at least a tri-band Yagi on top of the tower for capacitance to ground. It also assumes that the quarter-wave, driven wire is resonant and is in place. Because of the capacitive loading of the tri-bander the top wire is not very frequency-sensitive to pruning. The opposite is true of the driven wire. 12-inches change in length of the driven wire makes about 75kHz change at 75 meters. Change the top wire more.

If you have a tall tower (50-75 feet) I recommend you build the triple-tuned K0EOU design. If your tower is short, or you can't accommodate two widely-spaced driven wires, my double-tuned version will still give you very-good band coverage. Either way, the pruning and installation effects are the same.

This antenna is an excellent performer. It blankets all states with a strong signal. I call it my "Double-Tuned Tower Radiator".

W6EMD Equivalent Lumped-Element Schematic



R1 = Radiation resistance of 3/4 wave circuit.
R2 = Radiation resistance of 1/4 wave circuit.
C1 = Coupling capacitance between wires at far ends.
L1 = Coupling inductance of common portion of tower.
C2 L2 = Remainder of 3/4 wave circuit.
C3 L3 = Remainder of1/4 wave circuit.
G = Generator (feed point)

ANTENNA SWR

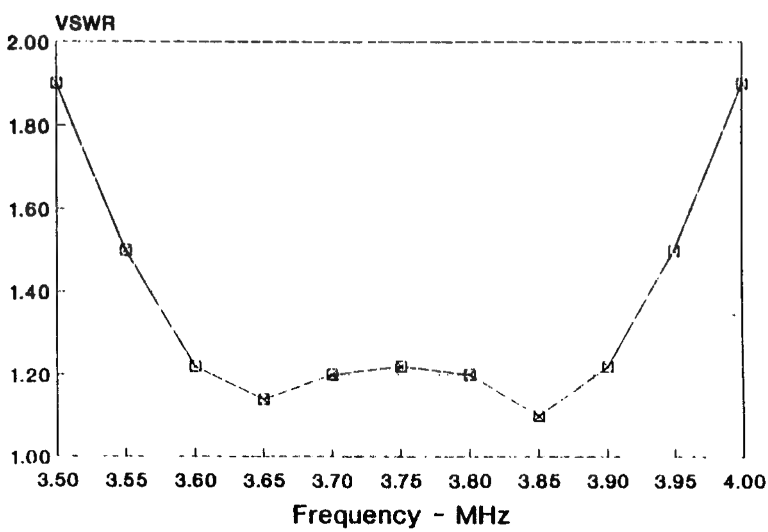


Figure 2

Approximate Top-Wire Length

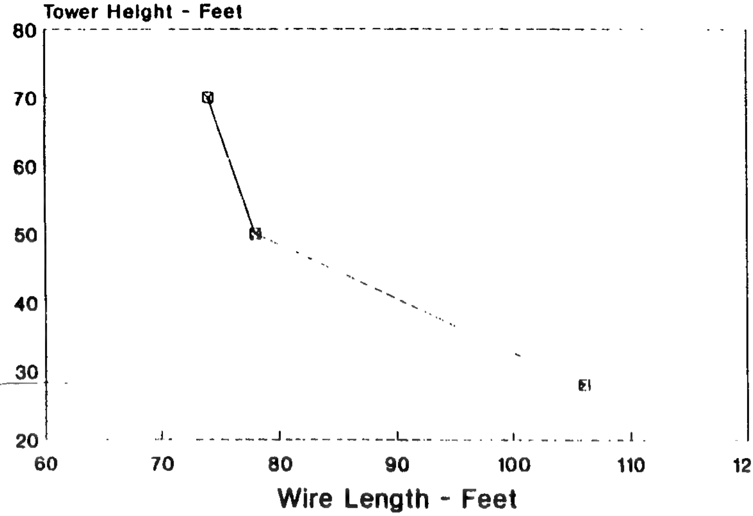


Figure 3

Cleaner Keying for the Ten-Tec 509

Larry East, W1HUE
1355 S. Rimline Dr.
Idaho Falls, ID 83401

While giving my Ten-Tec Argonaut 509 a good going over recently, I discovered that the keyed output waveform is far from ideal; its fall time is very fast (less than 0.25 ms) and its rise time ranges from greater than 5 ms to less than 1 ms depending on the setting of the output drive control. The fast fall time results in noticeable key-up clicks. Clicks can also occur on key-down when the drive control is set for maximum output. Since the keying circuit in my 509 is "stock" (at least it matches the schematic), I assume that these keying characteristics are fairly typical. I have not had access to other Argonaut models (505, 515) to check their keying waveform, but this condition may well be present in them also. If it is, the modifications described below may apply to the other models.

The keying signal for the 509 is derived from the "T" (transmit) control signal generated on the control board. "T" provides bias voltage for the RF amplifier and drivers, mutes the receiver and in conjunction with an "R" signal (basically the complement of "T") performs various other control functions necessary to switch from receive to transmit. The "T" signal is also fed to the CW drive control, R5, which is ganged with the microphone gain control, R7, and labeled as "DRIVE" on the front panel. A portion of "T", as determined by R7, is fed to the SSB generator board and is used to control the gain of the IF mixer when in CW mode. In CW mode, this mixer is purposely unbalanced in order to provide a carrier signal; controlling the mixer gain consequently controls the carrier level. In SSB mode, the mixer is balanced and runs at maximum gain; the SSB signal level is then set by R7 which controls the microphone amplifier gain. The rise time of the CW signal so generated is determined by a 0.22 capacitor (C18) and R5; however,

as the setting of R5 is changed, the rise time is changed as well. To make matters worse, a zener diode, D1, on the SSB generator board used to limit the gain controlling voltage to the mixer will cause the rise time to become very short if R5 is turned beyond the point at which output power no longer increases. (No additional output power is produced because the control voltage is being clamped by D1). When the key is released, the CW carrier decays with the "T" signal decay, which is very fast. Hence the presence of key-up clicks.

After I got all of this figured out, It became clear that the way to control the rise and fall times of the CW carrier was to control the rise and fall times of the "T" control signal itself.=20 This can be done by a fairly simple modification to the control board. The modification consists of removing capacitor C18 and modifying the "Transmit" switching circuit to provide the necessary shaping. The modified switching circuit is shown in Figure 1. After this modification the keyed output rise time will be about 3 ms independent of the drive control setting, provided it's not turned beyond the point of maximum output. The fall time will be about 2 ms, slow enough to eliminate the generation of key-up clicks. (Increasing the fall time aggravates another problem which must also be fixed, as described below.)

To make this modification, proceed as follows (I assume that you have a manual for the 509; use it to locate the components referred to below):

1. Remove the control board; it is located on top of the chassis behind the "DRIVE" control.
2. Remove C18. This capacitor is mounted under the drive control (R5/R7) and is ratherinaccessible. You may be able to clip one end free and push it back out of the way. Otherwise you will have to remove the front panel and the drive control to reach it.
3. Remove R1 from the control board; use solder-wick and try to get it out in one piece.
4. The next step is to drill mounting holes in the control board to re-mount R1 and to mount the shaping capacitor (Cx in Figure 1). Use a No. 60 drill (0.040 in.) and carefully drill holes as follows (see Fig. 2):

Near the collector of Q1 and another into the +12V trace so that R1 can be re-mounted directly adjacent to R2.

Into the ground trace and just in front of R5; Cx will be mounted using this hole and the original hole connecting R1 to the bases of Q2 and Q3. Position the new hole so that Cx will fit between Q1 and Q2. (A small molded tantalum is recommended; a small radial lead tantalum or electrolytic can also be used).

5. Using a small sharp knife (eXacto, etc.), carefully remove a section of the printed circuit trace connecting the collector of Q1 and the base of Q2.
6. Solder a 1/4 (or 1/8) Watt 3.3K resistor and 1N914 (or 1N4148, etc.) diode on the bottom (trace side) of the control board between the collector of Q1 and the base of Q2. (The cathode end of the diode connects to the base of Q2). There is not much room for these components after the board is remounted due to wiring under the board, so position them as close to the board as possible being sure that their leads do not contact other PC traces.
7. Using the new holes drilled as described above, remount R1 (on the component side of the board) between the collector of Q1 and +12V.
8. Mount Cx (on the component side of the board) with its positive lead in the hole originally connecting R1 to the base of Q2 and its negative lead in the new hole passing through the ground trace. (Refer to Figure 2.) I found 2.2 to be about right; if you want slightly "softer" keying, you can try 3.3. I do not recommend using less than 2 or more than 4 .
9. Re-check that you have performed the above steps correctly; if everything looks OK,

remount the control board.

Sorry, but you're not finished yet! The "T" signal is used to disable RIT offsets during transmit (a small VFO offset is still present, but much less than during receive). The timing for disabling the RIT during transmit is rather marginal in an unmodified 509, but it seems to work OK until the "T" signal fall time is increased. Increasing the fall time of this signal results in the RIT offset (if any) being restored before the transmitter output is reduced completely to zero. This can produce noticeable "thumps" (not really "clicks") at the very end of every transmitted "dit" and "dah" when an RIT offset is in use; not a good situation. Fortunately the problem is easily solved by using the "R" signal for RIT disabling rather than"T". The "R" signal drops to zero shortly before "T" increases above zero, and begins rising with a long time constant when "T" returns to zero.

A simple inverter, shown in Figure 3, is required in order to use the "R" signal to disable RIT offsets. I built this circuit on a small piece of "perf-board" and mounted it "spider web" style above the RIT control pot; the wire from the collector of the inverter transistor to the switch on the rear of the pot holds the board in place. The RC time constant at the base of the transistor insures that the RIT offset will remain disabled until the transmitter output is completely off. The diode across the base resistor discharges the capacitor quickly when the "R" signal drops to zero ensuring that the VFO frequency will be completely switched back from any RIT offset before the transmitter output begins rising. With the component values shown, the RIT is switched off about one millisecond before any measurable transmitter output and switched back on about one millisecond after transmitter output falls to zero.

To complete the keying modification, proceed as follows:

1. Build the circuit shown in Figure 3 on a small piece of pc-board, perf-board, or whatever you like to use for simple "once only" construction. Be sure it is small enough to fit into the space just above (or behind) the RIT control. Note that the diode must be a Ge (1N34A, etc.) or Shottky type; a standard Si diode (1N914, etc.) will NOT do the job because its forward voltage drop will be too high to provide a low resistance discharge path for the capacitor. The transistor can be just about any Si NPN switching transistor; I chose a 2N3904 because of its low collector to emitter saturation voltage (typically less than 0.2V).

2. Remove the TX-RX Mixer board; this is the small board on top of the chassis behind the VFO shield enclosure.

3. Locate the wire from the RIT on/off switch that goes under the TX-RX Mixer board. Remove the ends of this wire from the switch and the connector block under the Mixer board, but leave the wire itself in place.

4. Re-connect the end of the wire under the board to the connector block terminal to which the "R" signal is connected; this should be the second connection from the opposite end of the connector block, but check your manual.

5. Mount the inverter board above (or behind) the RIT control and connect the lead from the inverter transistor collector to the now empty RIT switch terminal.

6. Connect the end of the wire that was removed from the RIT switch to the inverter input.

7. Check your work and replace the Mixer board.

That's it; now its time to try it out! If you have an oscilloscope, use it to verify the keying waveform; otherwise, listen to the output on another receiver (being careful not to overload it). Also make sure that the RIT still works, and listen to the transmitter output while varying the RIT control (with it ON, of course!); there will be some shift in transmitterfrequency, but there should be no "thumps" or other extraneous output result-

ing from varying the RIT control.

For best CW shaping at maximum power output, increase the drive control until the power output no longer increases and then back it off just a bit. Setting the drive control "wide open" will result in key clicks and not produce any additional output power. You should also keep in mind that running much more than 5W output from "stock" finals can degrade the spectral purity of the output signal.

Now you can operate you faithful little Argonaut without fear of generating any interference from a poorly shaped CW signal!

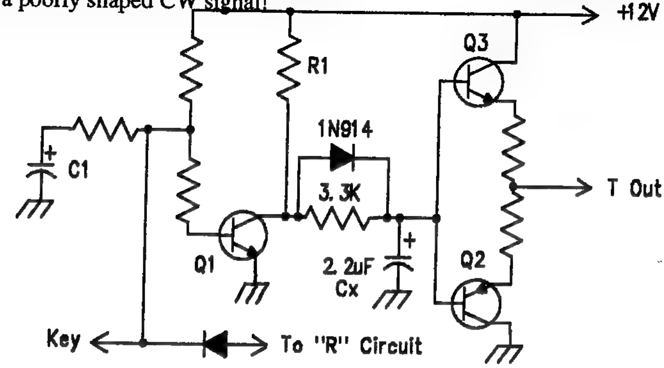


Figure 1 Modified circuit to generate transmit control signal.

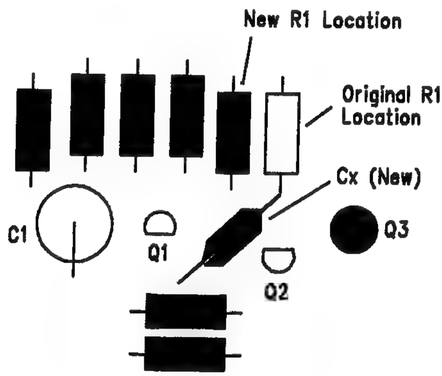


Figure 2. Parts placement on control board.

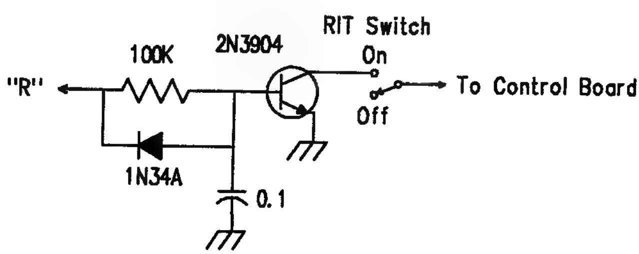


Figure 3. Inverter circuit required to use "R" signal to disable RIT during transmit.

The Future of the NorCal 40A & Sierra

by Jim Cates, WA6GER, Doug Hendricks, KI6DS, and Wayne Burdick, N6KR

The NorCal QRP Club has done two very successful kits that have set the standard for club projects. The demand for the kits continues and thus NorCal QRP Club is faced with a dilemma. Do we want to become a "Kit Company"? No, NorCal is a club, not a business. The purpose of NorCal is to promote QRP, and we feel that we do a good job. The development of the NorCal 40A and the Sierra, QRPp, and the monthly club meetings are good examples of what the club is about.

The success of the NorCal 40 and Sierra kits has forced us to make a decision. We are at the point where we must decide whether to in fact become a "Kit Company," or pull back and remain a club. We have chosen to pull back and remain a club. Our focus and job is to encourage new developers with new projects. We feel that we have the knowledge and expertise to help in the development stage of QRP projects. NorCal has a formula for success that has worked very well, and we will continue to use it. The past history of NorCal and our club kits has shown that we can help designers produce a short run of kits that get field tested by the best in the "business," our members. We have a membership base of well over 1000 who are eager and willing to "field test" QRP designs. The NorCal 40A and the Sierra are prime examples of this. Wayne designed these rigs, NorCal kitted them, and our members purchased them at a reduced cost. Who benefited? Everyone. Wayne got invaluable feedback on his design, NorCal learned how to kit and do developmental work, and our members got the opportunity to get in on the ground floor of a good project at a very reasonable cost. It was a win-win situation. But, there comes a time when these projects go past the club kit stage, and they need to become commercial kits. The NorCal 40A and the Sierra have reached this point.

That is why NorCal QRP Club will not be offering any more NorCal 40A or Sierra kits. But don't despair. The kits will be produced by Wilderness Radio, which will become the supplier of NorCal 40A and Sierra kits. They will be the same quality that NorCal provided. They will continue to be called the NorCal 40A and the NorCal Sierra, because they are still NorCal radios, with a NorCal heritage.. they are just not NorCal kits. Wilderness Radio is a separate entity and not connected with NorCal QRP Club. It is the next step in the logical progression of these rigs to a commercial product.

NorCal will continue to help designers develop projects. We will have more kits in the future, but we will only do short runs and we will not do long term distribution. That is not the purpose of NorCal. The designer owns the designs and as soon as they are commercial quality, they should be offered in the commercial marketplace.

To summarize our position, NorCal QRP Club sees that it will fill the niche of encouraging and helping our members develop QRP projects. We will help with R&D funds for worthwhile projects, and we will sell club project kits to members, but not as a long term obligation. That is not our focus, nor should it be.

How does this effect the members? We think that it will be positive. First of all, it insures that the rigs will be available if the market is there. Second, it will let the club focus on new and different projects, rather than tie up the club's resources with the same projects. Thank you for your support in the past and NorCal asks that you continue to support future club projects as well as Wilderness Radio.

NorCal QRP Club has grown beyond the wildest expectations of what Jim Cates, WA6GER and Doug Hendricks, KI6DS, had when the club was formed. The growth has not been without problems, and we have had to make changes to meet the demands of the club. Jim receives an enormous amount of mail that he spends a lot of time answering and keeping track of. He is the organizer of the club, and he keeps track of the money. When

we started, Jim also did the kits, separating and stocking literally thousands of parts in all of those NorCal 40s and Sierras. But due to the growth, Jim doesn't have time to stock kits anymore. We have found other club members to take care of that task. We want Jim writing the letters and answering the mail for all of the members. He is wonderful at his job, and we have had to get him some help with the kits, and we have done that.

QRPp is still done by me in my daughters' old bedroom on an IBM Clone and laser printer. It was easy to get them printed, folded and stapled when membership was 200. Even 500 wasn't too bad. But when the membership passed 1000, it became time to change the way that we did QRPp too. We now hire the printing, folding, stapling and preparation for mailing. To do so costs money. That is why the subscription rates went from $5 per year to $10 US, $15 (US Funds) Canada, $20 (US Funds) DX. But there is no other choice, as the number of subscriptions to QRPp has grown so large that I need help.

Is this growth bad? No, we think that it is good. We are reaching many more people with products that they are interested in. Some of our members wanted the kits, some wanted the information in QRPp, and some wanted both. Because we have such a large membership base, we are able to draw on a much larger pool of talent than the average QRP club. That has made NorCal special. That is why we have lots of exciting new articles in QRPp, why there are projects waiting in the wings to be developed and kitted. The reason that the NorCal 40A came about was that the original builders of the NorCal 40 came up with literally dozens of mods that made the rig better. That might not have happened had we been a small club of 10 or 15 members. Big is not always bad.

NorCal QRP Club has a bright future as does QRP. Thanks again for all of your help in making NorCal QRP Club what it is, and all that you have done for QRP in general. 72, Jim, Doug & Wayne

Wilderness Radio: Who, What, When?

by Wayne Burdick, N6KR

When you hear "Wilderness Radio," think Bob Dyer, KD6VIO. I met Bob the same day I met Doug and Jim, at Livermore. I was brandishing my multi-band QRP rigs when Bob walked up and said, approximately, "...so, if you ever want to start a company to sell these QRP rigs, let me know." One thousand club members and a few major projects later, it's time to take Bob up on his offer!

Bob is uniquely qualified to begin this part-time enterprise. He thrives on QRP and homebrew, is very well organized, and is about as personable and level-headed a guy as you'll ever meet. Bob has a degree in Zoology and has bird-watched in more countries than many of us have worked. Yet another hobby that requires patience! On the technical side, he has years of experience with spectroscopic equipment. This background helps explain his rapid ascent in Amateur Radio: he went from Novice to Extra in just 18 months, has worked over 110 countries QRP, has built much of his own gear, and is president of the EMARC Radio Club in Los Altos.

I would love to have started Wilderness Radio myself, but I have a great job already and just enough spare time to tinker with new radio designs. I'll be helping Bob get started, along with Dave Meacham, W6EMD, a retired EE, who has been helping me take some of the rough edges off the Sierra for the next production run. He's a whiz with filters and transformers.

You can call Bob at (415) 494-3806, or write to him at Wilderness Radio, P.O. Box 734, Los Altos, CA 94023-0734. He's currently taking orders on the NorCal 40A. The Sierra will follow in the Fall, in conjunction with my construction article in the 1996 ARRL Handbook. Check with Bob for prices or to get on his mailing list. 73, Wayne

TIDBITS by Mark Cronenwett, KA7ULD 1029 Duncan Ave. Sunnyvale, Ca 94089

Have any ideas that you would like to share with others? Well here is the place to do just that. Send your ideas to me at the address above, or by E-mail to mcron@sgi.com via the Internet.

PROTECTING RUBOFF LETTERS

From: Paul NA5N

Rob WA3ULH discussed using clear fingernail polish to protect rub-off letters from ... well, rubbing off. DATAK (who makes rub-off letters for electronics) also has a clear protective goop with brush. Frankly, the clear fingernail polish is about the same and probably much cheaper.

Another alternative is to use KRYLON No. 1306 WORKABLE FIXATIF spray coating. It is available at art and office supplies (vice a hardware store). A can will last for years. You spray it on just like paint. It goes on as a shiny coat. I usually put on a rather light first coat to just bond the letters, then a heavier 2nd and/or 3rd coat. If you put a real heavy 1st coat, the letters can dissolve! With a light 1st coat, let it dry, then dump it on, works very well. Its nice in that it puts an even protective coat over the entire panel surface. Each coat dries in a few minutes (no overnight thing).

The Fixatif is meant for protecting pencil sketches. I have used it on pencil drawn schematics of ham projects ... put on a light single coat, and the pencil won't smear and its quasi-water proof. It also works GREAT for weak photocopies. If you make a photocopy of a data sheet or schematic (or preparing camera ready art), the Fixatif slightly dissolves the graphite on the photocopy, blending it together for an impressive look. Also, the graphite won't thereafter flake-off. On a previous suggestion of doing the front panel lettering on a PC and photocopying onto a clear plastic carrier, I have used the Fixatif to bond the graphite to these plastic sheets. There is also a drafting film available with a self adhesive back which can be removed after photocopying. Its kinda a foggy white. The Krylon, if applied a little heavy, seems to convert the foggy matte look into more clear and transparent. The backing can be removed to expose the adhesive and applied (stuck) to the panel directly. The Krylon coating will help keep the letters from flaking off.

Paul NA5N

SOLDER FLUX FUN!!

From: Dennis, K1YPP

Just wanted to make a few quick comments on the solder/flux dialog: The old rosin core solder can tend to leave some ugly looking brown material on the joints, but from an operational perspective, it is reasonably insulated and at DC and low frequencies it doesn't do a lot of harm. It is wise to clean off as much as possible, but the effort may have diminishing returns. It is especially difficult to remove if it is very old.

The water soluable stuff is very easy to clean. A mild handsoap and warm water works very nicely, the soap isn't even necessary. Contrary to the rosin solder however, it really should be cleaned if high frequencies or extremely small currents are involved.

If this stuff is used with CMOS circuits, or devices such as the Unitrode UC3906 battery charger chip, strange things can occur if it is not cleaned off. A CMOS chip, such as the Curtis Keyer 8044ABM will start to key itself, or not key at all etc. The UC3906 previously mentioned has currents as small as 10 microamps, and this flux, if left on, can offer paths as low as a megohm between pins on the IC. Things can vary with temperature and humidity and drive a builder crazy if they are not aware of this flux being on the board.

I prefer the water soluable stuff, it is more pleasant to work with, but must be cleaned off.

72, Denis

NorCal 40a Variable Bandwidth Xtal Filter Mod.

by Monte "Ron" Stark, KU7Y
285 W. 4th Ave Sun Valley, NV 89433
ku7y@sage.dri.edu

The NorCal 40a is a very nice radio. One of the things I like about it is that you can do so much with it. I have added an AF volume control (which Wayne keeps saying I don't need!), and a keyer. The keyer is based on the Curtis 8044ABC chip. So far, so good.

Good radio and I could have left it just like it was. But what the heck, why not look for things to keep making it better?

Wayne Burdick E-Mailed this idea to me awhile back and yesterday I got around to trying it. What is it? How about making the crystal filter a variable bandwidth filter? Take four resistors, three diodes, one capacitor and mix with a little solder, wire and a few minutes of your time and presto, you have a nice working variable bandwidth filter in your 40A. I haven't measured the response of the modified filter but judging by the seat of my pants I would say it goes from over 1 Khz to about 100 Hz. In the wide position you can hear both sides of a signal. In the narrow position all you hear is the station you are listing to. Wayne is using a similar system in his Sierra with good luck.

Parts needed: 3 - MVAM108 Varactor diodes. (I got mine from Newark Electronics), 3 - 100K 1/8W Resistors, 1- 10K Linear Taper Pot, 1 - 0.1 uF Capacitor

Now comes the fun part. You will need to drill a hole in either the front or rear panel. I chose the front because there isn't any more room on the back on of mine.

1. First remove C10, C11 and C12. These will not be reused. Use care in doing the removal. This is a high quality board but with enough abuse it could be damaged! If you have a hard time getting things off boards, cut the leads and then remove the lead. Clean the holes with a solder sucker and or solder wick.

2. Install one end of each of the three 100K resistors where the removed capacitors connected to the crystals. Connect the free end of these restores to the wiper of the 10K pot.

3. Connect one end of the 10K pot to ground. I used a piece of wire from the pot to the ground hole of C12.

4. Connect the 0.1 uF capacitor between the wiper and the ground end of the 10K pot.

5. Connect the other end of the 10K pot to the regulated 8vdc. I connected a wire from the pot to R20. Use the end of R20 that is facing away from the front panel. DO NOT connect to the R17 side.

6. I chose to mount the diodes on the bottom. Mount them where the original capacitors were located. Connect the cathode to the crystals and the anode to ground. Use the picture in the 40A manual to orient the diodes correctly.

Do the normal checking for solder bridges etc. Then fire it up. I took the time to realign the whole rig. Then I started playing with it. Wow, what a rig. I leave the filter wide while tuning and calling cq. Then, while in qso, I narrow it down until it seems right! The more qrm the narrower I go!

Enjoy the rig and give the thanks to Wayne, both for the rig and the mod. Atta boy, Wayne!

72's, Ron, KU7Y

P.S. There are 2 filters in the Sierra. To make it wide enough to listen to ssb you need to add one of the diodes to the second filter also. Wayne has all the details. Just e-mail him for the info.

The NorCal QRP to the Field: Mt. Baldy Expedition

by Paul Harden, NA5N (pharden@nrao.edu)
120 Garden Circle
Socorro, New Mexico 87801

Five hams from Socorro, New Mexico, decided to scale Mt. Baldy Peak to operate the contest from the nearly 11,000 foot summit. Calling the Forest Service, we found out no one had yet made it the top this year and the status of the road was unknown. About 8:00 am, armed with two 4-wheel drives, QRP rigs and foul weather gear, off we went. All was fine until about 9,500 feet when we entered "Sherwood Forest," about a half-mile stretch of road through tall pines that never sees the sun! The hard icy snow covered road and the snow drifts offered the road virtually impassible. But after considerable time getting stuck, digging paths with shovels and simply ramming the snow drifts with our 4WD's, we finally made it through Sherwood Forest. Oddly, there was little snow at the summit. We called the Forest Service monday morning and informed them "the road to Mt. Baldy is NOW open" We figured they owed us big bucks for this service!

Doug AB5WT digs out his Jeep while Paul NA5N works on the next snow drift with his Land Cruiser.

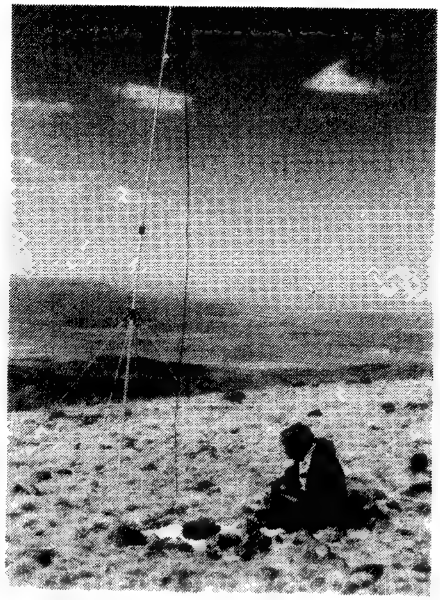
The participants were:
• Paul Harden, NA5N
• Doug West, AB5WT
• Dave Finley, N1IRZ
• Chuck Broadwell, W5UXH
• Howard Peavy, K9PV

Near the summit there is an old comet observatory building, where we setup. Doug AB5WT and Dave N1IRZ setup their stations near the northeast corner of this building to shroud themselves from the cold, bitter wind. N1IRZ worked 20M CW and hung his dipole between a weather station mast and the end of a 60-foot boom crane parked nearby in an E-W direction If only we could have raised that boom! (We checked; no batteries installed). Doug stretched his 40M dipole from the same weather station mast to a bracket on the observatory dome, running N-S to be opposite Dave's antenna. This arrangement seemed to cause little interference between the two stations. N1IRZ made the first "to the field" contest QSO a bit after 12:00 noon and AB5WT shortly thereafter ... a mere 4 hours after leaving Socorro. (The summit is about 25 miles from Socorro). N1IRZ used his QRP+ while AB5WT was true to the cause by using his NorCal 40.

Paul NA5N setup along a ridge south of the observatory building, stretching his 40M dipole between his Land Cruiser and a self-supporting 16-foot mast taken along for the occassion. About 100 feet away was a large cable roll, which Paul felt would make a better "desk" than the small table he had taken. It took over a half an hour, but Paul finally rolled the cable roll, and unrolling the cable wire still attached, to underneath the center feed of the dipole. It made an authentic "to the field" operating fixture for his station, as shown on the photo page. The resulting splinters combined with cold fingers made for some interesting CW keying. Paul used his "mini-rack" of homebrew and heavily modified MFJ gear on 40M CW.

To his credit, Chuck W5UXH was the only one to operate from the actual summit. He backpacked his NN1G and other earthly belongings (like lunch) and hiked to the summit. Chuck put up a 40M inverted vee from a 16-foot telescoping mast he hand carried and QSO'd a few stations. However, after fighting the elements, he retreated about 2pm and setup his station again several hundred yards west of the observatory building and operated some more.

Howard Peavy K9PV had to leave town after us and decided not to tackle "Sherwood Forest" by himself (a wise decision). He operated his station from a campground inside a canyon amidst tall pines with fair success. He strung a 40M dipole between two pines up about 30 feet using the fishing-line-and-rock-technique. Howard operated his NorCal 40 in the prone position on a sleeping bag ... an operating posture Howard said he'll not do again. Howard camped the night here.



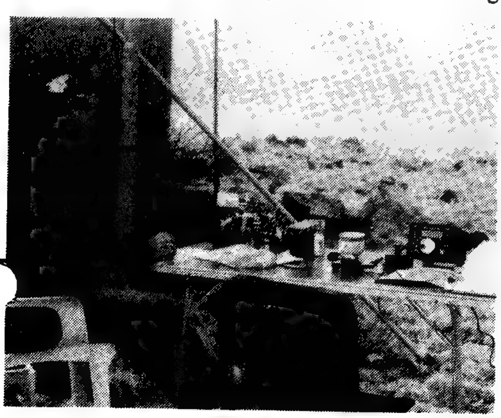
Chuck W5UXH operating from the summit. The view was spectacular. We think the haze on the horizon is the Pacific Ocean.

It was still wintertime above timberline in New Mexico: the wind blew the entire time, the weather was cold (41 degrees at 3pm) and it finally beat us about 4pm when we tore down the stations and retreated to warmer ground. Inspite of our harsh environment, the contest was fun. To demonstrate how the weather worked on us, notice the photo on the next page of AB5WT stringing his antenna, wearing only a shirt and no hat. The photo below is an hour later; Doug has by now donned a heavy coat and ball cap. Another photo on the next page was taken about 3pm; Doug has reverted to full foul weather gear. All of our "dress codes" seemed to change in a similar manner.

We found no tactical advantage from our mountain top location, at least using dipoles. Verticals, offering a lower radiation angle, would probably be more effective. The QRP "to the field" exercise was fun. We'll be back next year, either from Mt. Baldy (with verticals) or another unique "to the field" location. A date a little later in April might offer better seasonal weather.

The excellent photos in this article were all taken by Dave, N1IRZ. Somehow in the all the excitement, we unfortunately never got a photo of him or of Howard K9PV. But with no photos of them, it makes is easy to just say "they were the handsome ones in the group!"

-- 72 de your friends in New Mexico



Doug AB5WT working his NorCal 40 with Dave N1IRZ's QRP+ 20M station on the right.

Doug AB5WT raising his dipole from the weather station mast. The wind speed instrument was missing two blades!

NA5N's station and dipole "up 10,700 ft." The actual summit is in the rear where W5UXH setup his first station.

NA5N working 40M CW with his "mini-rack" QRP station, powered from the cup of hot coffee and corn nuts.

Doug and the AB5WT/N1IRZ station, by now well bundled up. He's not smiling; he just froze up stiff that way.

All photos courtesy Dave Finley, N1IRZ

What's your story? Send your story and photos to QRPp editor Doug Hendricks, KI6DS

Back Issues of QRPp

Back issues of QRPp are available in bound issues only. Volume I contains the 3 issues from 1993, and Volume II contains the 4 issues form 1994. Volume I is 140 pages and costs $10, while Volume II is 296 pages and costs $15. Both years are $25. To order, send your money to: Doug Hendricks, KI6DS, 862 Frank Ave., Dos Palos, CA 93620. Make all checks and money orders out to Doug Hendricks, and NOT to NorCal! DX orders please include $10 extra per order for postage. All prices are for US Funds only!

Curtis 8044ABMKeyer Chip and Far Circuits Board Combo

NorCal has made a bulk purchase of the Curtis 8044ABM Keyer Chip and is offering it with the Far Circuits Board and the Info Sheet for $17.00 Postpaid. DX orders add $5 shipping. US Funds ONLY!! Make Checks or Money Orders out to Jim Cates, NOT NorCal! Send your orders to: Jim Cates, WA6GER, 3241 Eastwood Rd., Sacramento, CA 95821.

NorCal QRP Club

QRPp is published at Dos Palos, California 4 times per year: March, June, September, and December. Subscription fee is $10 per year for US residents, $15 per year for Canada, and $20 per year for DX. To join NorCal QRP Club send your name, call, and address to Jim Cates. There is no charge for membership to NorCal QRP Club. To receive QRPp, you must subscribe and pay the fees. Send your money (US Funds ONLY) to:

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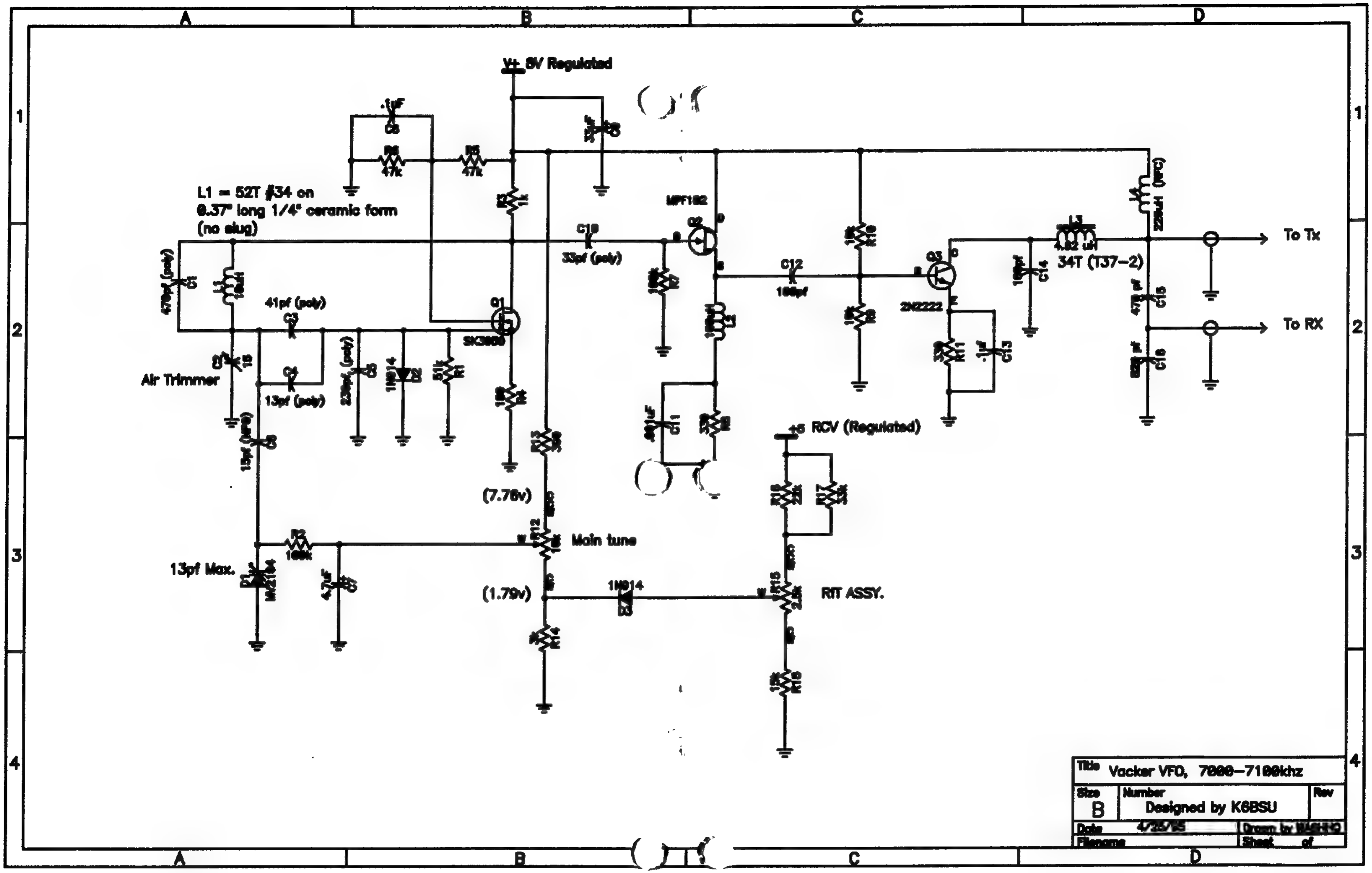
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L1 = 52T #34 on
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(no slug)
MPF102
2N2222
34T (T37-2)
To Tx
To RX
41pf (poly)
13pf (poly)
33pf (poly)
Air Trimmer
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(7.76v)
Main tune
(1.79v)
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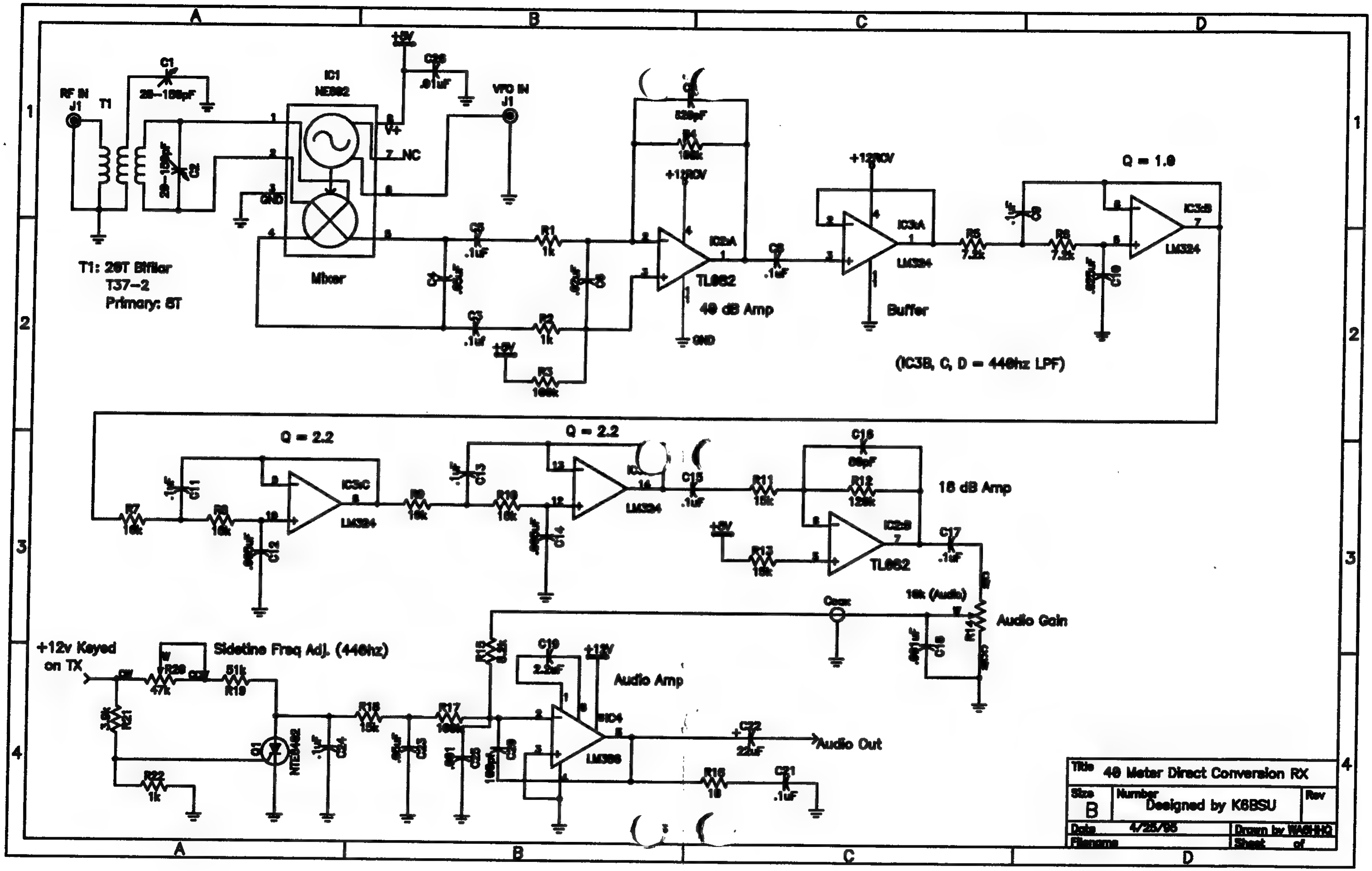
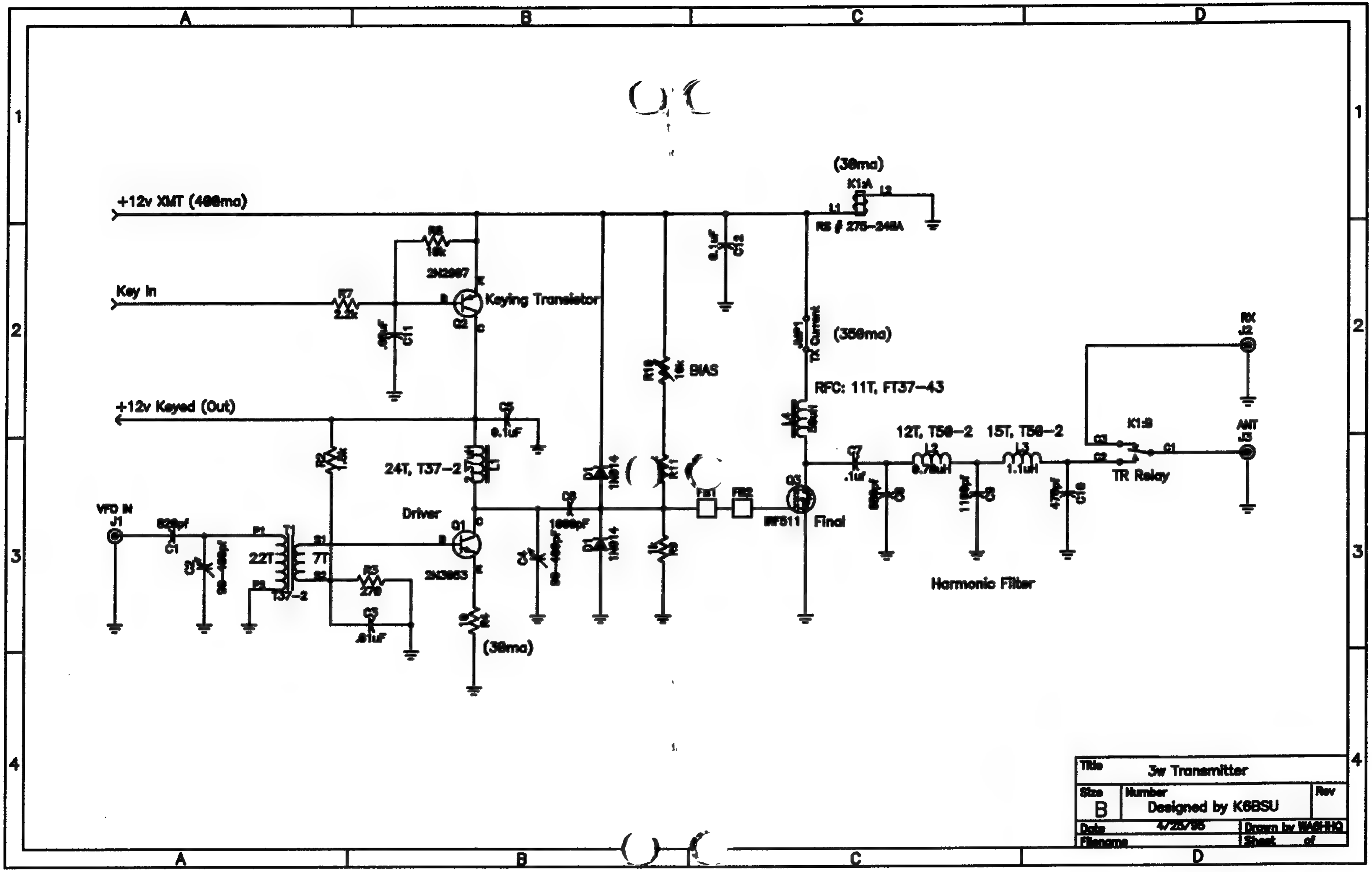


40 Meter Direct Conversion RX
Designed by K8BSU
RF IN
VFO IN
T1: 20T Bifilar
T37-2
Primary: 6T
Mixer
40 dB Amp
Buffer
(IC3B, C, D = 440hz LPF)
Q = 2.2
18 dB Amp
Audio Gain
Audio Amp
Audio Out
+12v Keyed
on TX
Sidetone Freq Adj. (440hz)



+12v XMT (400ma)
Key In
+12v Keyed (Out)
VFO IN
J1
820pf
C1
22T
7T
T37-2
T1
R3
270
C3
.01uF
R8
10k
R7
2.2k
C11
2N2907
Keying Transistor
Q2
24T, T37-2
C5
0.1uF
Driver
Q1
2N3053
(30ma)
C6
1000pF
1N914
BIAS
C2
0.1uF
(30ma)
K1:A
RS # 275-248A
TX Current
(350ma)
RFC: 11T, FT37-43
Q3
IRF511
Final
FB1
FB2
C7
.1uF
12T, T50-2
L2
0.75uH
15T, T50-2
L3
1.1uH
Harmonic Filter
K1:B
TR Relay
RX
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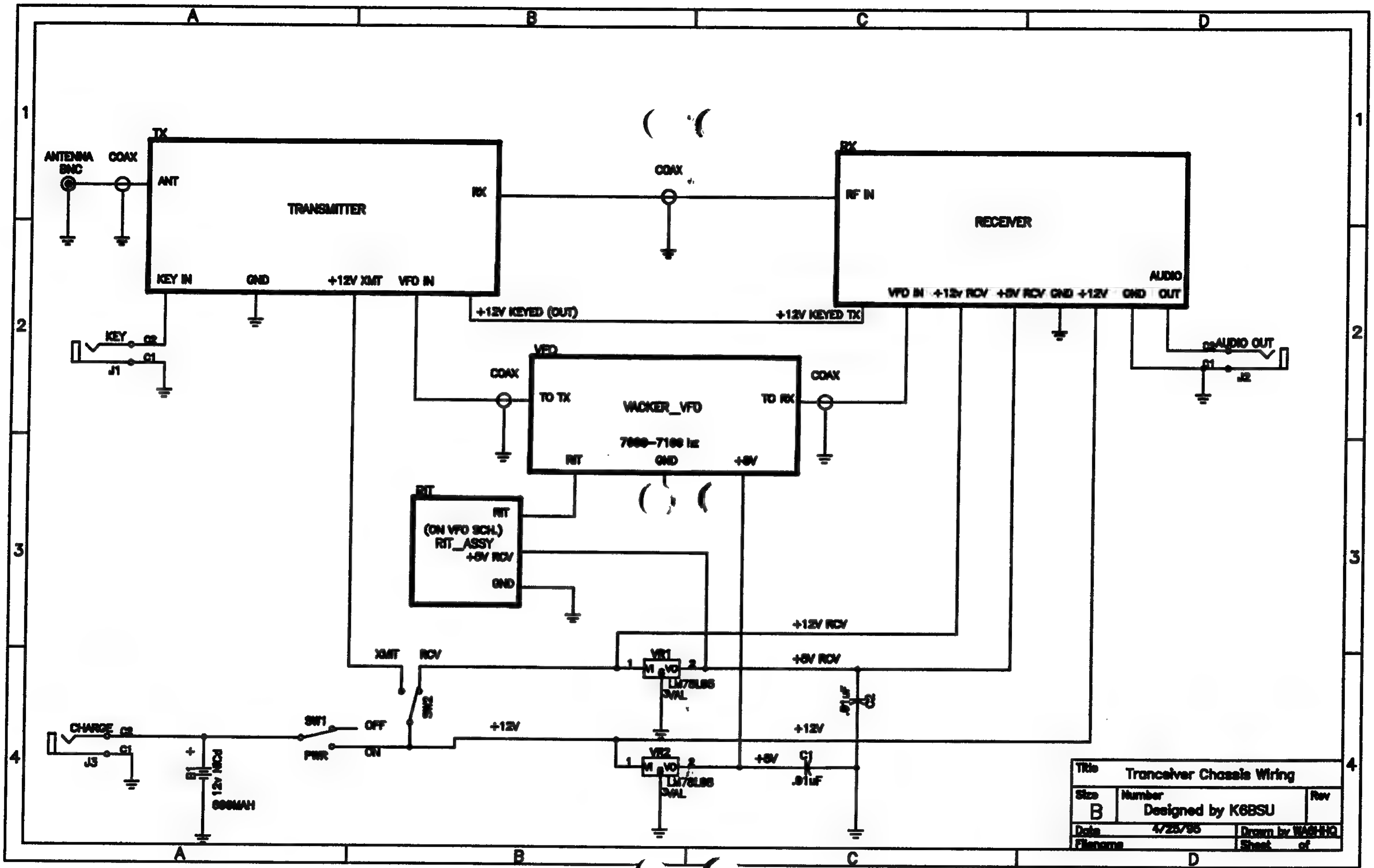

ANTENNA
BNC
COAX
TX
ANT
TRANSMITTER
RX
KEY IN
GND
+12V XMT
VFO IN
+12V KEYED (OUT)
+12V KEYED TX
COAX
RX
RF IN
RECEIVER
AUDIO
VFO IN
+12v RCV
+5V RCV
GND
+12V
GND
OUT
AUDIO OUT
J2
KEY
J1
VFO
COAX
TO TX
VACKER_VFO
7000-7100 hz
RIT
GND
+5V
TO RX
COAX
RIT
RIT
(ON VFO SCH.)
RIT_ASSY
+5V RCV
GND
+12V RCV
XMT
RCV
VR1
LM78L05
+5V RCV
SW2
CHARGE
J3
SW1
OFF
PWR
ON
+12V
+12V
VR2
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QRPp

Journal of the Northern California QRP Club
Volume III, Number 3, Sept. 1995

From the Editor
by Doug Hendricks, KI6DS
862 Frank Ave.
Dos Palos, CA 93620
Phone: 209-392-3522 Internet: dh@deneb.csustan.ed

Summer is fast drawing to a close as I write this at the end of July. There has been a lot going on, and it is exciting news. The Cascade sales were phenominal. We kitted 200 of the kits, and have most of them spoken for. Hopefully all will have been shipped by the time that you read this.

In the March issue, I printed an article on the Neomyte, which was a cigarette sized 75M SSB transceiver by VE7TX. Joe has updated the article, and we should have it ready for the December issue. Also, coming in the December issue will be an article on the Cascade, by John Liebenrood. And we will have a full report on the results on the QRP to the Field Spring Contest that was sponsored by NorCal and run by Bob Farnsworth. There was just not room in this issue for everything that we wanted to print.

This issue does feature some great articles and I would like to draw your attention to the announcement on the availability of NorCal Membership Certificates on page 63. Bob Finch contacted me last winter and wanted to know why NorCal didn't have membership certificates. I explained to him that no one had thought of it, and that no one had done it. He offered to take care of the matter, and now we can take advantage of the fruits of his labors. He has done an outstanding job in true NorCal fashion. Please remember to make out checks and money orders to Bob and not to NorCal when you place your order. Thank you Bob for stepping forward and taking care of this.

I have more exciting news. Plan on attending the Pacific Division ARRL Convention at the Concord Hilton Hotel in Concord, California Oct. 20-22. It will be an exciting weekend full of QRP activities. We have firm plans for 2 QRP sessions, in the large lecture room. John Liebenrood, K7RO the designer of the Cascade and Derry Spittle, VE7QK who designed the Epiphyte, will speak on Saturday on SSB and QRP. Wayne Burdick, N6KR, will talk about his latest CW designs and then Stan Goldstein, N6ULU will tell you how to work over 100 countries with a NorCal 40 at the Sunday QRP session. NorCal will sponsor a hospitality room at the NorCal - ARCI booth on both Friday and Saturday nights. Several of the National Officers for ARCI are planning on attending, so it will be a chance for you to meet them. They are helping with the booth costs for the second year, and we thank them for their help.

CORRECTION: Floyd Carter, K6BSU, sent me the following corrections for the "73 Special" that was printed in June QRPp. **Receiver:** 1. A 100K resistor should be added between +5V and IC3, pin 3. C8 also goes to IC3, pin 3. 2. On IC2 the +12V should be on pin 8. Ground is pin 4. 3. On IC3 ground should be pin 11. **Vackar VFO:** 1. The lower end of C1 should be grounded, not to C2, C3 etc. 2. R12 is a 10T Helipot with turns counter dial. 3. C4 should be a 13pF N330 ceramic disc (temp compensation). 4. Subs for the SK3050 are NTE221, NTE454 or RCA40673. **Building Tips:** 1. K1 in the transmitter can be replaced with a st of contacts on the T\R switch, use a DPDT. 2. Use a bolt on heatsink for Q3. 3. An NTE612 will sub for the MV2104 varicap. 4. In the receiver a TL084 will sub for the LM324. Floyd also has photos showing the enclosure, and circuit boards which will help in the construction. If you are building the rig please don't hesitate to contact Floyd, but please send $1 if you want copies of the photos, and if you are writing for help, include a SASE, #10 business sized. Floyd's address is: Floyd Carter, 2029 Chist Dr., Los Altos, CA 94024.

One last note. I am running for election as the Western Representative on the ARCI Board of Directors. I would appreciate your vote. Thanks, 72, Doug, KI6DS

AA7QY Field Day Report

By Roger Hightower, AA7QY
1265 W Kiowa Cir.
Mesa, AZ 85202
aa7qy@primenet.com

Well, it's over. Interesting exercise...my first as a QRP station on natural power. Lots of activity, as I'm sure you all know, but not too many folks had ears for qrp stations. Most of my contacts were with the West Coast, Texas and Colorado. I did pick up Utah, Idaho and South Dakota, which are rare in any case.

31 qso's only, but had limited operating time and was stuck on 40M the whole time. The only qrper I heard was NA5N answering someone else's CQ, and didn't have a chance to call him since the frequency was in use.

I ran the QRP+ to a random wire with a 7.5 amp gel-cell charged by a solar panel, and did have a lot of fun. CW only, since I haven't received the back-ordered mike and haven't gotten around to making one that works.

The real excitement of the weekend was a Saturday night visit by a black bear some 30 yards from my station, tearing up a stump looking for grubs. Abby, my Springer Spaniel did a lot of woofing and growling, but fortunately did not get the bear's attention. It did put an end to the night-time operations, though. Discretion, valor and that sort of thing. Fear, really!!

Hope all of you had a great time. Sorry I missed you, and will work harder next time. Maybe the QRP Afield thing this fall.
72/73, de Roger, AA7QY

NW QRP Club Field Day Report

By Brian K High, KV9X
352 N 101ST St
Seattle, WA 98133
nwqrp@scn.org

Whew ... what a weekend! The NW QRP Club's Field Day effort was a lot of fun. We had visits from two local papers (SW Wash. area). We made the 2nd page of one of them on Sunday with a picture of Bill, N7MFB working RS-12 with two QRP +s. The uplink used a tuned 20M loop (reduced size, mast mounted at about 15-20'). The downlink used a 15M/10mMyagi at about 25'. Unfortunately, the caption in the photo said we were just tuning in a broadcast. Oh well. We expect to have something in a weekly paper as well. We also used an 80M Bic (TM) dipole at 50' fed with 300 Ohm tv twin lead, a sloping 40M loop, two 20M phased verticals, a 10/15/20M 3 element yagi, and a 5 element yagi for 2M at about 30'.

We had a lot of trouble with interference between the two transmitters, especially when one was on 20, 15, or 10M. While we moved the 15/10M yagi, the press was shooting away at the spectacle (we moved it without lowering it). This didn't really help, particularly since the real problem was that the SWR was off. Once it was properly tuned things worked out okay ... at least for Saturday. Hi!!

The Bic (TM) worked well on 40, but the loop (sloping to about 8') did better. We did use the Bic (TM) all night on 80M and 75M SSB. I made it the night before we left ... what a light-weight antenna! I will use it backpacking this summer (to Alberta I think). I may want to build one of Roy's (W6EMT) "Z-Match" tuners. His was really nice. (He had a great CMOS Memory Keyer also ... Thanks Roy!)

Unfortunately Marcia's call-sign didn't come in time, so we didn't run a Novice sta-

tion. She had a lot of fun, though, and learned a lot. She has the feeling she will really enjoy contesting when she gets her code speed up.

I hope y'all had a ball as well. I bet you did!

72, Brian, KV9X

FD '95 Report from La Estancia de los Guajalotes Sonrientes

By Nils Young, WB8IJN
126 W. Main St.
Medway, OH 45341
NYOUNG@nova.wright.edu

Ok, so I get home from work on Friday, having field tested the Argosy set up on the parking lot light poles. So I unpack everything and put it back in the shack and go out to eat and take my medication and try to keep from going out into the shack but I can't. So I futz around out there for a while and then come in. Cindy catches me at the fridge: "Mom called. Tomorrow is the Fire House Pancake Breakfast. We're going to go over around 9 and eat and then watch the parade. And you have a haircut appointment at 12:30."

I wish I had more whiskey. I drink some seltzer with a twist of lime and go back out to the radio shack. I solder some wires together and burn myself and then come inside and prepare to crash.

I get up the next morning around 8. Andy (the youngest) is downstairs watching some sort of mind-numbing anti-intellectual pap on "Nicktoons." I go out to the shack and look at some stuff. I can feel one of those killer headaches coming on. I go into the house and eat two ibuprophens and two acetaminephens and drink a big glass of water. Cindy shows up. We begin the Saturday morning rushing around and getting ready to do something that we call relaxing. We find my keys. We go to grandma's and the firehouse and eat and watch the parade. The headache has begun to tip the scales toward minor convulsions in a dark room waiting for a quiet death. I go back home, eat some more pain killers, drink a half an espresso and go back to get my hair cut.

"I hope this haircut can kill this headache," I say, walking in the door. The scissor-wielding blond (I'm not so far gone I can't recognize good-looking women) says "Sit down, honey. I'll be right with you."

I sit. She cuts my hair. It's a Hemingway bit. Simple sentences. A conversation. She finishes my hair. I look in the mirror. I look good. I am ready for a job interview. I look normal. My headache is gone. I pay and give her a substantial tip.

When I get home, all the pain killers have finally taken control of my brain. I go upstairs, put on my cut-off jeans and pass out. Five hours later, around 6 p.m., CIndy comes up to get me. We have a dinner reservation at one of the fancy places downtown. One of the few places downtown still open, now that everyone else has fled to white suburbia and the security of little housing developments where you can't put up an antenna. Been there. Done that.

We go to eat. The food is good. I get to thinking about Vygotskian stuff and write a whole course outline on a dinner napkin. A paper one. The table, in fact, is covered with a square of white paper. I write more stuff on it. Cindy and I talk. Caves, buildings, how the food tastes. Postmodernism. The usual.

We go home. I go out to the radio shack. Everyone is having a good time. I have decided that I will not start out 1D and then suddenly become 1B or something. I check the equipment. It works. I am happy. I go in the house, take a shower and hit the sack.

Sunday morning dawns. I get up and find Andy watching some more mindless pap. Out in the radio shack, I open up the Argosy and change the timingon the AGC. Then... ah,

then.. then I notice why the frequency has been so jumpy. I park the radio and listen. The freq shifts. The back thrust bearing on the PTO is cracked. Straight through. And now... now comes the interesting part.

I set to removing the PTO. In the course of leaning over the bench to fix the radio, I somehow screw up my back. I have to very carefully pull myself erect, lower myself into a chair and then try to figure which way to lean so that I don't get the "knife in the back" pain to which I have become not at all accustomed over the past 10 years or so. And I still have to fix the PTO.

To make an already long story short, by the time I fixed the PTO (and it's weird why Ten Tec never made the shaft on the PTO run to ground...thus leaving the user with a strange "hand capacity effect" or whatever they used to call it), it's 1 hour left of FD. I listen around. Everyone is very slow and very quiet and I think that they must be all just about burned out. I go back into the house, take four each of every pain killer that I've got and go upstairs to lay down. Cindy has stripped the sheets off the bed. The PTO is fixed and I could give a hoot less about civility. I roll, groaning in pain, onto the bed and fall asleep. Three hours later, the pain is still there and now... now it's time to go to the grocery.

So my FD experience this year — one that would, I thought, mark an end to nearly 10 years of radio silence in this house — came out to this:

1 contact. On 40m. The Friday before FD. 5 watts into a light pole in the university parking lot. Great fun, this.

So, how'd it go for youze people? Chigger bites? Lyme disease? Cold beer? Warm beer? Wasps come zooming in? Fall asleep over the key, sending out a continuous stream of "dits"? Run out of gasoline? Oh, weather. How was the weather? I think we need a complete rundown on the weather. Yep.... so....

The weather here was sunny on Friday, very hot and humid with a few thunder showers now and then. The lightning did not hit the light pole. I was careful. On Saturday it was on and off again and it didn't make much difference anyway. Hot and humid. Sunday, I don't know. I slept through some of it. And the rest of the time I was too busy cussing and groaning.

Oh, did I mention that I also had to take Andy over to the crazy toy store to get him a "big, rubbery fish"? Well, I did that too. It was cool. They have rubber chickens and rubber fish and rubber faces. There's one that has a bunch of fingers where the mouth should be. One of Ian's friends wore one on the way to the house on Halloween. Scared the crap out of Andy. He had a little problem with that "momentary suspension of disbelief" thing. Wayne came in the house. Andy took one look at Wayne. Wayne made the fingers wiggle. Andy ran and hit behind his mother. SO much for the big rubbery Wayne. That's why we had to get the big rubbery fish. Appease the rubbery gods, I think it was.
73 Nils WB8IJN

Athens County Ohio ARA Field Day

By Eric McFadden, WD8RIF
12600 Adeline Cir.
Athens, OH 45701
wmcfadden@ohiou.edu

Greetings, fellow QRPers! Field Day 1995 is over. The Athens County (Ohio) Amateur Radio Association (ACARA) competed in category 1A from the County Fairgrounds. Our Field Day team consisted of six members, about half being CW ops, the other being Phone men. We operated under the callsign W8MHV. This was the first Field Day the

ACARA has participated in as a club in several years.

We installed an 80/40m fan dipole between a large tree and a flag pole and a 15/20m fan dipole between two trees. We operated from an open picnic shelter, but had a tent in case the bugs got too bad—they didn't—and a mobile home in case the thunderstorms got too bad—they didn't. It didn't rain during set up, but did rain nearly all night.

Our rig was the club president's Argonaut 515, and we tried his newly-purchased MFJ 20m CW rig for a short while. The only significant problem we had was QRM; the Argonaut lacks an IF CW filter, and the Radio Shack DSP unit we tried wasn't ideal for the very crowded bands. (Our back-up rig was my HW-8, a fine rig for occasional use, but it would have been dreadful for Field Day! I'm glad we didn't have to use it!)

We ran off of batteries, being charged by a 28 watt solar panel. (I found the lack of generator noise to be very nice.)

I provided my Idiom Press CMOS Super Keyer II for the CW operations. The other two CW operators hadn't used a memory keyer before, and I think they are converts now—they both expressed interest in building their own.

We logged to an old, tiny, Sharp sub-notebook PC, using WR9Y software—it was a great program. We also logged to paper, Just In Case.

I haven't gone through the logs yet, but we made approximately 260 QSOs, mostly on CW. I don't know if this is a good score—I'll have to wait for the QST results in November—but we felt good about our effort.

We set up after 1800z Saturday, to take advantage of the 27 hour operating period. We were very surprised to hear that the bands just shut down at 1800z Sunday, so the extra three hours we had were very unproductive. It appears that maybe we should have set up early. I speculate that most of the groups set up early, so they can't operate past 24 hours.
72, Eric. WD8RIF

AB5OU Field Day Exercise

By Tim Pettibone, AB5OU
1661 Alta Vista
Los Cruces, NM 88011
tpettibo@NMSU.Edu

Had to stay home but operated my new QRP+ off of battery power. Antenna was Zepp up 15' (about 6-7- ft long, who measures?). Yep, the QRO stations weren't listening real good. Worked 60 in 33 sections in around 10 hours of operation all on 40/20m. Even snuck a few casual q's in on 30m! Had fun, already sent in my log to ARRL! Love my QRP+!
Tim AB5OU

G5RV Comparison on Field Day

by Bob Hightower, KI7MN
1905 N. Pennington Dr.
Chandler, AZ 85224
bobhigh@primenet.com

Well, with all the discussion on the effectiveness of the G5RV on 30 meters, and with Field Day being the perfect opportunity to string antennas, I used two antennae, at right angles to each other, one HB and one commercial, both 40' or better off the ground.

The HB antenna did indeed tune and work well on 30 meters (using a TS450SAT), while the commercial antenna did not. Hmmmmmm.... both are cut to the same length, and, purportedly, use the same wire. Only difference is in the center insulator. Obviously

there is some other electrical difference that I don't have the expertise, equipment or time to measure.

Anyway, it seems that, with a good tuner, the G5RV will work on 30...maybe. Nothing definitive here, at all.

I strung the two antennas up at right angles as an experiment, using an antenna switch, to see what the difference in propagation would be for the states to the north of us. Not much, really. Some of the calls to the Eastern states were made with the wrong antenna, with better reports than from those on the antenna oriented that direction. But, there were no problems noted, seemingly no coupling of any kind, even though the ladder lines/feed lines were somewhat close. One benefit was that if I couldn't hear a station, I just flipped the switch, and, in most cases, there they were, much better. Have to do this again.

Also strung up the Bic Flamethrower. What a little jewel this is. Working with both the QRP+ and the NorCal 40A, it was an absolute wonder. Light, easy to erect and very easy to tune, this one is a keeper.

Hope all had a good time on Field Day, as we did at about 8000' in North Central Arizona. Look for you all at the fall QRP Afield.
73 Bob KI7MN

NN9K Field Day Results

by Peter Beedlow, NN9K
741 Greenway Ave.
Colona, IL, 61241
PB13128@deere.com

Call: NN9K
Class: 1B (2 operators: K9WA & NN9K)
Section: IL
Power output: 5 watts. CW only

Band	QSO's
80	95
40	151
20	228
15	54
TOTAL	528

Equipment and antennas:
Radio: Icom IC-735
Antennas: 2 McCoy dipoles at 65 feet and 1 old, 1957 vintage tribander, at 20 feet.
Logging: Laptop powered from station battery supply runninn NA.

Ought to be more operating events (read: contests) that allow QRP power with single transmitter and 2 operators. Very relaxing!
Hope you all had fun,
72/73, Pete, NN9K

N9RJ Field Day Report

By Russ Johnson, N9RJ
760 E. Freeman Ridge Rd.
Nashville, IN 47448

johnsonr@indy.tce.com

My plans to get the club to use my new QRP+ for Field Day didn't work out too well. The others wanted to use a REAL rig ie Kenwood TS-690. That was ok I guess even though they should have at least given the QRP+ a try. They started out at 5 watts but it wasn't long before the were turning the power up to 15 watts then to 50 watts so I said why stop at 50 just turn the thing up to 100 watts and forget QRP so they did.

When my turn came to operate I fired up the QRP+ and it really worked great. I don't have the log sheet printout yet (used PC with CT logging program) so can't recap the numbers yet but I had very good success on CW. I didn't try SSB as I was the only CW Operator this year.

My first session was 2:00 to 4:30 am Sunday morning on 80 Meters. Ran at about 25 per hour rate with one half hour with 25 contacts. It was all search and pounce as calling CQ didn't seem to net as many contacts. About 6:00 am Sunday I tried 40 for a while then the phone guys took over again.

There were two guys interested in the QRP+ and were very impressed with it but would not operate the EVENT (see Chuck, I remember it's NOT a CONTEST! hi hi). We did play around on 30 Meters a bit but the receiver was not happy with the other rig on 40 so next year I think I'll try band pass filters for 30, 12, and 17.

We had a fair turnout of ops, only a few hours of rain, and only one BIG thunderstorm (2 inches of rain in 40 minutes) so another sucessfull Field Day.

Hope you all had fun too. 72, Russ Johnson N9RJ

FD '95 and More

By Preston Douglas, WN2V
216 Harbor View N.
Lawrence, NY 11559
PDouglas12@aol.com

. I had four friends punk out—and it rained. So operated 1E alone at home and made 81 QSOs operating a few more hours than Nils (who easily takes first place for the best FD report.) Made 40 of the QSOs with the SW80 (Hello, Dave Benson, the new 2N3553 did the trick and it puts out a solid 1.5w. Must have blown the original with the spurious junk caused by putting the wrong toroid core in the xmt bfo. Thanks for the help.) Another discovery: RIT is not needed for FD!

No question, the CMOS II memories were the best anti-fatigue, anti-error aide ever. I will never contest again without it. Unpaid endorsement: The CMOS II by Idiom Press (see any QST, I don't have the address handy) is easily the best buy out there in memory keyers. I programmed one memory with the exchange. One had a FD CQ. One just my call sign (sent the exchange while logging—even grabbing a sip of caffeine—very easy.) Made only two QSOs calling CQ. That's about the right ratio—one out of forty QSOs calling CQ with one watt.

Ran all battery with SW80, NW80/20 on 40m, Explorer20, and old Digitrex on 20M SSB (one lousy phone QSO). .. and took a lightning hit. It made a six inch scar from 40 feet up my big tree down the bark into the ground, and underground to my gas line (no explosion, thank God.) Due to impulse/induced/ secondaries (who knows), we lost two tvs (just out of warrantee), two computers (warranteed) one phone and one alarm system, assorted light bulbs, and one GFI protected outdoor electrical circuit. Scared the crap out of us at 3am. Obviously, I wasn't operating. (I'm too old for all night contesting.) Rigs were grounded and d/c'd from all antennas, so no damage in the shack. I leave 'em that way when not in operation. You should too. Funny how it hit that tree 65 ft from my tower

(attached to the back of the house) which is kept cranked down to 30' and is well grounded. Maybe it (the tower) protected the house under its umbra.
Preston WJ2V

FIELD DAY - No Challenage for my QRP!

By Dennis Marandos, K1LGQ
42 Cushing Ave.
Nashua, NH 03060
k1lgq@dennis.MV.COM

Field Day is over and I lost! I didn't just lose, but I went away weeping. My QRP rigs were NO match for the big guns out there in KW land. I set up a station in Holderness, NH (Golden Pond) on Squam Lake and pitched three dipoles. I was on 20 and 30 and 40 meters, which was great. I had my extra car battery charged and ready for some serious number crunching activities. I was going to make some big scores on this contest if I had to stay up all night doing it.

When two o'clock in the afternoon rolled around, I was just finishing my last dipole. I ran into the shack (a screened area facing the lake) and 'got on.' Now the big BUT of contesting. I could hear them, but they couldn't hear me. I made two contacts (15 seconds a piece) in two hours. I was frustrated! I, for some unknown reason, brought my TS-450SAT and tried to make a few points with higher power. I filled 8 pages!

I believe the playing field is pretty loopsided with QRP and that the real contest will be this September 16 with QRP AFIELD. In that contest, the playing field will be level and all the players will be using the same tools. It's going to be a contest for QRPers, and not QROs!

As with all contests, there is the weather factor. On Saturday the WX was in the 80's with a gently breeze coming off the lake. When the contest was winding down, I could hear thunder in the background. At 1:45 EDT Sunday, I thought it was about time to remove the dipoles off the trees. I got all the wires down, the rigs all packed away, the car loaded and headed for the dirt road. Three minutes on the road, from the cabin site, the sky opened up and Armageddon poured for an hour of steady monsoon rain. BUT, I didn't get wet!

I am looking, no I am gunning, for the QRP AFIELD in September! Watch out RF, here I come. Dennis - K1LGQ
Editor- New England QRP Club newsletter

NORTEX FD

By Henry Smith, NA5K
1380 Camino Real
McKinney, TX 75069
hbs@crl.com

I would classify the NORTEX (North Texas) QRP Group Field day outing as a success. We set up in a little park in Richardson Texas.

Antennas:

Loading up the rail road track that ran beside the park seemed to work but we encountered problems every time a train came by. It seems that when the road crossing gates went up, our antenna become rather discontinous.

So we loaded up the celluar radio tower that was on other side of the park.

After virtually shutting down the North Dallas celluar corridor, we decided to revert to our back up antennas which was a pair of 140' long wires at 90 degree angles (no

kidding). This gave us good coverage.

Participation:

We had 6 to 8 participants during the more sane hours and had 4 all-nighters.

The big push was to have a good time and to allow some of our less-experienced CW ops to have a go at a contest. We had success in both catagories.

A note to Dennis, K1LGQ:

You are correct, it was tough, especially right after the starting gun. But using a few tricks, you can level the playing field and make lots of contacts. More on this next year.

Thanks to all who came out.

Smitty, and the NORTEX gang.

It's A Dupe!

By David Johnson, WA4NID
2522 Alpine Rd.
Durham, NC 27707
djohnson@acpub.duke.edu

Here is a true account of a really (at least to me) hilarious situation that happened when I went to visit the CFD (Chatham County Field Day) this past weekend. It was in the first hour or two of Sunday morning, local time. Paul Stroud, AA4XX, was kind enough to show me the 40m cw qrp station (connected to phased verticals) and to let me operate awhile. Bob, KE4NBC, was dupe checker at this position, and he stayed on while I began to operate. Paul was hanging around either in the tent or just outside for awhile, and I was using the headphones as a speaker (like I do at home a lot with the Sierra). I was using a pencil to copy calls and then told them to Bob, who checked for dupes. Paul was copying in his head, and several times would say "it's a dupe" immediately upon hearing the call.

Well, I don't know how long he had been operating at this position, but it seemed that he had a good short-term memory, as he was invariably correct in these pronouncements.

Ok, now for the funny part. Seems like six or seven times Paul made these judgements (correctly, as determined by Bob's checking the dupe sheet), and Paul wanders off from the tent. I keep operating with the headphones as speakers, and copy another call. Way off in the distance I hear this faint voice, a barely discernable whisper: "it's a dupe"! I looked for Paul and he had disappeared in the darkness, but must have been 50 feet away!

Not only did he correctly remember all those calls, but he was copying the audio from the station when he was halfway across the field! I started laughing uncontrollably, and Bob did too (sorry to WA3ULH, Rob, operating in the same tent at another rig, who suffered some local qrm!), because we were straining our eyes in disbelief, trying to determine how far away Paul was! There wasn't too much light on the field, but that audio sure must have been weak in Paul's ears! Of course, when Bob checked the sheet, sure enough it WAS a dupe.

I went on to work some more stations, and had a great time operating. But the best part was the incident described above, when Paul demonstrated both his extraordinary short-term memory and his exquisite ability to copy the weak signals, with that unforgettable phrase from across the field: "it's a dupe!"

Have fun hammin'! Dave, WA4NID

N2JGU QRP FD95

By Gary Diana, N2JGU
65 Pacer Dr.
Henrietta, NY 14467
gmd@rfpo1.rfc.comm.harris.com

Brad WB8YGG and I got together for a third QRP Field Day. We setup a tent, operating table, etc so we could operate the whole weekend regardless of the weather. We operated as N2JGU 1B WNY, QRP of course. Our QTH was approximately 40 miles west of Rochester NY.

Equipment:

TenTec Argosy 80-10m SSB/CW
HB Sudden RX/ Cubic Incher TX for 80M CW
HB Epiphyte 75M SSB + 5 watt amp
HB NN1G 80m CW
Misc. 2m fm equipment

We put up a 80m ladder line-fed dipole at about 35'. The site had just enough trees for the dipole, and had a great view toward the southwest. We setup Friday afternoon, and were getting S9 to 20 over signal reports from Ontatio Canada, NY and PA on 75m Sideband at QRP power levels.

We made about 300 contacts (290 more than last year!), split 50-50 between SSB and CW. Most contacts were on 80m and 40m, with a few on 15m and 20m. One interesting note was that few things had to be repeated on the CW contacts! Was it better OPs, or the conditions? On Saturday morning we cobbeled together a 4 element "Fred Flintstone" 2m Quad with #12 house wire, straight out of the Antenna Handbook. It worked like a charm, but looked pretty primitive. That gave us communications back into the local Rochester repeater.

We went through two gel cells with the Argosy, and had a solar cell going which allowed us to monitor 2m for free. The wx was in the high 80s/low 90s and it was HUMID. A rain storm cooled things down for a while on Saturday, but then the high humidity returned. Brad took some digital pictures with a camera he borrowed from work, and they should be appearing on the Internet soon. All in all we had a great time and have some ideas for a better FD next year. I guess it's back to reality now as we re-pay our wives for letting us get away for a radio weekend!

73 Gary N2JGU

NORTEX FD - What We Did

By Henry Smith, NA5K
1380 Camino Real
McKinney, TX 75069
hbs@crl.com

We are not the experts, this was our first Field Day. But we did sit down and think it out before we started.

1. Put up the best antenna that you can get in the area. Mike Dooley, KE4PC, was the antenna chairman. All antenna credit goes to him. We put up two 140 ft long wires which were perpendicular to each other. We used 3 20 ft poles for this. The antennas went right into the tuner, nothin' fancy.

The idea was to position the lobes of the 2 wave 20 meter longwire pointing to the NE, NW, SE and SW. The nulls were due North and South. This gave us some gain in the directions we wanted. The lobes of the 1 wave 40 meter longwire were not as pronounced but they were there never-the-less.

Mike kept track of the contacts on a map of the US and his predictions were righ on,

we worked 'em where we expected to. We could have gotten by with one antenna.

Remember, you are competing with beams on 20m, so you need to level the playing field a little. On 40 and 80, most stations use dipoles or verticals. Not as hard to compete here. Much more could (and probably will) be written on this subject.

2. We didn't start on 20 meters. What a mess that was! After we heard that, we went down to 40 meters where there were fewer stations. Just about everybody starts on 20. Later on when we felt that the crowd would be moving to 40, we went to 20 and stayed there until late in the evening. Then we went to 40. By Sunday morning, it was all dupes Also, 15 opened up for a while. Go where most stations ARENT. Actually if you didnt start until 1900 or 2000 UTC it wont hurt. Let the riot subside a little.

3. We didnt bother with calling CQ. Forget it if you think that you can hold a freq! We started at one end and gradually worked our way to the other end. If the station didnt hear us after 2 or 3 calls, we moved on. Finesse and patience.

4. Other:

Most stations cook along at 25-30 wpm, live with it.

If not sure, call any way.

Take breaks.

By dinner time on Saturday, your hotshot ops are hungry and go to din-din. Thats when they put in their new guys. That when our slower ops did their best.etc.

Saturday, some of our less experienced CW ops jumped in there and made some contacts. As they gained experience and speed, their contact rate increased. By Saturday night, they ran the show and milked 20M and 40M dry.

We aren't the experts and probably didn't place but just about every body made q's and had a good time.

Smitty for NORTEX
Henry Smith (hbs@crl.com)

KC4EWT FD: Fuse the Battery!

By Dan Johnson, KC4EWT
1225 Summerfield Dr.
Herndon, VA 22070
Johnson_Dan@AAC.COM

Having participated in club FD activities in the past, KC4EWT's tiny shingle wafted gently in the ionospheric breeze for the first time. The effort was rewarded by satisfaction which exceeds the contest score.

The goals were to make and test fixtures necessary to run from battery power and to operate a QRP FD station. Lessons learned:

1. FD can be done without widowing the family.

2. QRO FD is too easy, QRP puts the spice back, though it's easy (essential, perhaps) to forget that you're QRP because it doesn't matter as much as you'd expect.

3. Less important than power is hitting the sweet spot of the other station's receive filters.

4. It takes more time and planning than expected to convert one's station from power mains to battery power.

5. Fuse the battery (hi).

Locating the station in a sweaty but nearly bug-free wooden shed in the backyard provided less than optimal operating conditions while maintaining the ubiquitous balance between hamming and family responsibilities.

In QRO (100W) years past, I could snare most anyone I could hear. That wasn't the

case with QRP, but with surprisingly few exceptions, it seemed like the most influential factor was whether my 5W hit the right part of the receiving station's passband. Excursions of +/-400 Hz from apparent zero-beat often netted contacts. I conjecture that this was necessary either to get all of my signal inside their passbands or to hit the right audio pitch in their earphones. With a 250 Hz IF filter, RIT proved the most important transceiver feature.

A single deep-cycle marine battery, one of twins acquired to feed 24V to boatanchors, powered the event with plenty to spare. Construction projects included a power distribution box, cables, and a light source. I was too hasty constructing the power cable for the tuner meter's lamp. The coaxial power plug's terminals shorted near the end of FD, and the fried conductor acted like a toaster instead of a fuse, hence the lesson above about fusing the battery.

The ICOM 745, internally tweaked to run 2W minimum, ran 5W throughout the contest. This was my first opportunity to measure its power consumption. With a dead meter light, it drew 0.95A RX and 5.4A TX. For me, this emphasizes the distinction between ricebox and "true" QRP technology.

In 60 contacts over 7 operating hours with 5W on 40M and 20M, I worked 33 sections in all but call district 3, spanning the U.S. in every direction and including 3 Canadian sections. Not spectacular, but not disappointing, either. There were some good ears, with good operators between then, out there. I only worked one other "B" class, K9OM, but plenty of others were out there working "turf" stations.

KD4DFD dropped by to try his hand after 2000Z, but by then it became difficult to find contacts amidst QSOs.

Bottom line: despite the limited operating time and a "miserable" score by competitive standards, it was well worth the effort and well worth repeating.

My expectations this year were realistic resulting in no dissapointment. Next year, I'll expect to put a more efficient HB transceiver on the air and to improve the score from this year. One step at a time, guaranteed pleasure.
72 de KC4EWT EWT 1B 1B VA VA TU

Zuni Loop FD Report

By Doug Hendricks, KI6DS
862 Frank Ave.
Dos Palos, CA 93620
dh@deneb.csustan.edu

The eleventh annual Zuni Loop Mountain Expeditionary Force made their assault on Field Day from the Zuni Loop of the Table Mountain Camp Ground near Wrightwood, California. The campground is at an elevation of 7200 feet, and has a clear shot at the East. It is located about 50 miles Northeast of Los Angeles and is at the tip of the Sierra Nevada range.

The Zuni Loop Mountain Expeditionary Force was started in 1985 by Bob Spidell, W6SKQ, (who became a silent key in 1993), Fred Turpin, K6MDJ, and Cam Hartford, N6GA. It has always been a QRP Field Day operation, and has grown in size as the members have invited guests, who in turn have returned and invited others. The way that it has worked is that the first time you are a guest, and if you prove to be compatible with the group, then you become a member of the Expeditionary Force.

I first learned of the Zuni Loopers by reading accounts that were published in the QRP Quarterly, the Journal of the ARCI. Those accounts were like feeding candy to an orphan, I wanted more and I wanted to be part of it. It became a dream of mine, to go to

Field Day with the Zuni Loopers. Then, in the spring of 1993, I came in contact with Richard Fisher, KI6SN who just happened to be a member of the Zuni Loopers. He invited me to attend, and I have been going back evei since. It is like Dayton, once you

Zuni Looper FD Equpment: Most of the equipment in this picture is home brew. The only rigs that are not are 2 Mizuho transceivers and an MFJ SSB rig. All of the rest are rigs and accessories that were used by the Zuni's in their 1995 FD assault from Table Mountain Campground.

have been, you have to return.

The Zuni Loopers have been through a lot in their trials and tribulations of fighting the Field Day Wars. Bears have raided the camp. There was an earthquake one year, and in 1994 there was the Wrightwood Forest Fire that was only 2 miles from the site. It burned for several days before it was brought under control. But through it all, the Zunis have prevailed.

This year there were 17 operators with a total of 75 years of Zuni Loop experience! Here is the list:

Fred Turpin, K6MDJ - 11 Years
Cam Hartford, N6GA - 10 Years (he missed on his 25th wedding anniversary)
Keith Clark, W6SIY - 9 Years
Rob Roberts, N7FEG - 9 Years
Richard Fisher, KI6SN - 6 Years
Ralph Irons, AA6UL - 5 Years
Kim Irons, KD6WJK - 4 Years
Clark Turner, WA3JPG - 4 Years
Doug Hendricks, KI6DS - 3 Years
Charlie Lofgren, W6JJZ - 3 Years
Wayne Burdick, N6KR - 3 Years

Tom Brown, W6JHQ - 3 Years
Vern Wright, W6MMA - 1 Year
Jon Iza, EA2SN - 1 Year
Tony Gasparovic, N6OAT - 1 Year
Paul Carreiro, N6HCS - 1 Year
Bob Heusser, K6TUY - 1 Year

Fred operated 40 meter CW along with Tony and Paul. Cam, Keith and Wayne were on 20 and 80 CW, while Clark held down 15 CW and Phone and Rob did the same with 10 CW and Phone. Richard operated 2 M simplex, Tony and Paul helped with 2 M packet. Clark also did some 6 M phone and 1 6M CW contact. Ralph had the 40 SSB station, and Vern and Doug worked 20 and 75 SSB. Tom, Jon, Kim and Bob logged and Charlie (who is better known in Zuni circles as Charlie Tuner, was in charge of the tuners).

The Zunis are serious and famous for their antennas, and this year no exception. Here is the list, and please don't drool when you read this.

2 Meter Simplex	5 Element Homebrew DNA Quad. (Richard cut his thumb while building it, and it took 3 stitches to close the bloody wound. If he would have been involved in a criminal activ ity even the LA police would have had plenty of evidence.)
2 Meter Packet	Stacked Yagis, Top 4 element, bottom 3 element.
6 Meter Phone & CW	Dipole at 60 Feet.
10 Meter Phone & CW	Homebrew ZL Special, 2 element beam.
15 Meter Phone & CW	Homebrew ZL Special, 2 element beam. This is the W6SKQ Memorial Antenna. Bob Spidell built this antenna, and it is priceless to the Zuni Loopers. Bob watches us every year, and he is pleased that we think of him when we see his antenna.
20 Meter CW	6 Shooter. Made of 6 phased dipoles at 100' Dipole at 50'
20 Meter SSB	5 element Yagi at 55 feet on a rotatable Army Surplus tower. Skelton Cone at 40 feet.
40 Meter CW	3 element Inverted V Beam at 80 feet.
40 Meter Phone	Inverted V at 50 feet.
75 Meter Phone	Skelton Cone at 40 feet (same antenna as 20 meter phone, fed with homebrew ladder line and a tuner) Half Square at 62 feet. Half wave horizontal element (128') with quarter wave vertical elements.
80 Meter CW	W8JK which is 2 parallel full wave dipoles that are phased with 1/8 wave spacing at 90 feet.

Thirteen antennas, and what an antenna farm. Even Vern, W6MMA who has the best antenna system that I have ever seen was impressed. It took several hours to erect them, but boy is it worth it. The old sage about the antenna being worth 99 times more than power is certainly true at QRP levels. The question many of you are probably asking is how do they get those antennas so high? It is simple my friend. Table Mountain has hundreds of pine trees that are over 120 feet tall. The Zunis use a modified slingshot called a Wrist Rocket. They have added a Zebco 33 fishing reel to the front by clamping two 3/16" rods to the slingshot with cable clamps, and then mounting the fishing reel to the rods.

Fred Turpin is a master at shooting 3/4 ounce fishing sinkers over a tree limb. In the past Fred has used 4 lb. monofilament line, but this year he used 6 lb. test and it worked much better. Fred shot 2 antennas for me, and both of them were done the first time. The

process is simple, first the sinker and monofilament line, then heavy nylon string, then a small rope, if needed, with one line pulling up the other in sequence.

What about rigs? This year the Zunis decided to concentrate on using homebrew rigs. This was brought about by the emergance of all the great kits in the past 3 years. Here is a list of the rigs and homebrew accessories that we had at Field Day this year. We took a picture of all the rigs on a table, and you will get a chance to see it as it will be published in QRPp.

OHR SCAF Filter
OHR Sprint 30 Meters
OHR Sprint 40 Meters
OHR Explorer 40 Meters (2)
Cascade SSB 20 & 75 (2)
Epiphyte SSB 75 (2)
MFJ 9420 SSB 20
OHR Classic 20 & 40 CW
OHR WM1 Wattmeter (2)
CMOS Super Keyer II (4)
Sierra (4)
Homebrew 20 & 40 Meter Transceiver
SWL 40-40
Mizuho 40
Mizuho 6
St. Louis Tuner
NorCal 40 (4)
NorCal 40A
Homebrew Paddles
Junction Box
Z Match Tuners (5)
R2/T2 (Hands Linear, T2 Transmitter, R2 Receiver, Differential T Match, Low Pass Filter, W1FB Universal VFO)
Curtis Keyer (2)
HW-9 (2)
Argonaut 515 (4)
Yaesu FT 890
Yaesu FT900
Neophyte Receiver

Icom 502
HTX 202
Kenwood TS140
Army Surplus 55 Foot Rotatable Tower

As you can see we had quite an array of equipment, with 90 percent of it homebrew. How did we do? Well, we made 1039 contacts, and we think that we were in Class 6A. Cam will go over the logs and determine our exact class. Our point total was over 8000. The all time Zuni record for Qso's is 1199 set in 1993, and it was our goal to break it this year. But, we fell a little short. One of the problems that we had with the home brew rigs was that the Sierra was interfering with the Cascade on 20 and 80 and the Cascade was likewise getting into the Sierra. The front ends need to be beefed up if they are going to be used in a field day type of situation. The Cascade that we were using did not have the RF gain control hooked up, (prototype), and we certainly could have used it. This is a call to all of you. Someone needs to design some type of filter to keep the two rigs from bothering each other when they are used in close proximity. Even with the RF control on the Sierra, the interference from the Cascade was still there. Plus by turning the RF down so far, the signals were being attenuated by 30 dB!! To solve the problem, we started trading operating time, with the CW stations going for an hour and the SSB for an hour. Then when 75 opened, the 20 SSB station closed and we worked 75 SSB and 20 CW with no problems.

It was great fun and I certainly enjoyed the weekend with the Zunis. It was worth the 300 mile trip one way. I will be back next year. 72, Doug, KI6DS

K3WW QRP+ 1BBattery 1 OP

By Charles Fulp, Jr. K3WW
1326 N. 5th St.
Perkasie, PA 18944
CFULP@MCIMAIL.COM

Call & Class:
K3WW 1 B Battery, 1 operator

Location:
Pennridge High School Field (50 feet from my drive way) The location, close to home, in a valley, a hill to the north rises 300 feet in about 1/4 mile, other directions are not obstructed for some distance.

Equipment: QRP+, Azden mobile 2 meter radio, Icom HT and PacComm HandiPacket, Laptop computer. Gel Cells and Deep Cycle Marine batteries for power, plus fluorescent battery powered lamp to view LEDs. (The past 4 years I just used the glow of the screen and display of the IC 751A.)

Antennas: 80 40 inverted V dipole, center about 55 feet up on fold-over/telescopic mast of my own design. 20/15/10 dipole (the 40 dipole worked better for 15) single feed line center supported on same mast at about 50 feet. Hustler mobile antenna on van used for a few QSOS, 2 meter whip for 10 VHF (2FM) QSOS., rubber duckie antenna for packet.

Results:

80 CW	278
40 CW	237
20 CW	124
15 CW	64
Packet	90
2 FM	10

Looks like 7,980 points for contacts, plus most of the Bonus points except for Satel-

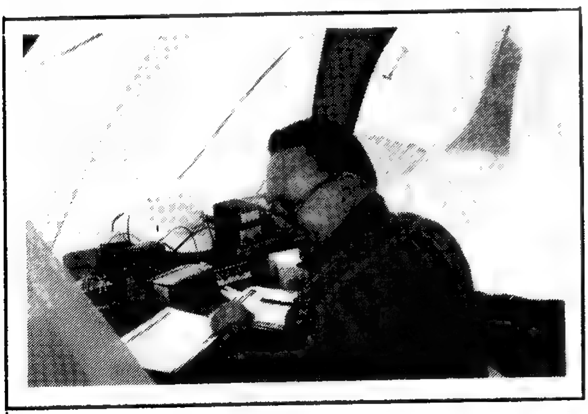
lite and (blush) Natural Power. The receiver in the QRP+ worked fine, it was never the limiting factor in making contacts. Had very high noise on 20 and above at times, but 80 was extremely quiet this year. I use dipoles because they are simple, and predictable. I think the energy needed to put up a beam or more complex antenna system would be counter productive to the operating portion of the event, for a 1 man operation.

This may be very close to a new 1 B battery 1 Operator record, I couldn't break it with my IC751-A, but more guys were on packet and conditions were close to ideal for my set up. The 5 multipler, in my oppinion puts QRP stations at an insurmountable advantage in Field Day, if point totals are important to you. Some day it would be fun to go for the all time point record, with a good QTH, big antennas and a dozen or more QRP stations. 73, Chas.

NorCal QRP Field Day in the Santa Cruz Mountains

By Stan Cooper, K4DRD
71154.331@compuserve.com

Dave Meacham, W6EMD, (pictured below) sent me an e-mail about a week before Field Day asking about my plans for the weekend. Dave mentioned that he, Eric Swartz, WA6HHQ, and Stan Goldstein, N6ULU, were planning to set up a two position operation atEagle Rock, an inactive Forestry Service fire lookout at 2800 feet above sea level just off of the Empire Grade in the Santa Cruz mountains. Eric and Stanhad used Eagle Rock previously, and as Eric described it, the site was a relatively flat circular shaped mesa about a hundred yards in diameter, with the lookout tower in the middle. The view in all directions was spectacular, with the Pacific Ocean to the west and Mount Hamilton on the horizon a couple of ranges to the east.I hadn't participated in Field Day activities since the late sixties, and readily accepted Dave's invitation to join the group. A couple of days later,Stew Bowers, WB6FBB, called to ask me about my plans, and he joined us as well. Lloyd Cabral, AA6T, had graciously agreed to let us use his call sign for the operation. What a great CW call!Leaving Redwood City about 8:00 AM, Dave and I caravanned to the site with both our cars loaded to the hilt. Eric and Stan spent early Saturday morning disassembling a 30 foot mast and loading it and a full size three element 20 meter Yagi onto Stan's pickup truck. Dave kept in touch with them via Eric's 440 repeater, and briefed me on their progress via 2 meter simplex (I've got to get on 440). We all rendezvoused at the gate to the site about 10:00 AM Saturday.At 11:00 (1800 GMT) sharp, I set up the Outbacker whip with copper foil radials and a solar panel powered Sierra on forty, and by 11:10 was on the air. While I was operating, the rest of the group raised the tower, secured it with three guylines, and Eric climbed to the top and installed the 20 meterYagi pointed due east. It wasn't long before the second position was up and



running on twenty using Stew's Sierra. Next we assembled and erected a 40 meter inverted vee wire "beam". For this antenna, we separated the driven element from the reflector with a twenty-two foot boom which was at the top of a thirty foot mast. Again, we pointed the antenna east. With the forty meter operating position at a new location closer to the inverted vee, we resumed operation. The wire beam's performanceon forty was outstanding, and as an added bonus it resonated on the CW end of fifteen meters as well.Although the group was pretty "laid back" with the primary goal to have a goodtime, we managed to log about 350 CW and a handful of SSB QSOs for about 3500 points. Saturday evening visitors included Eric's XYL, and Lloyd, AA6T. In all, two NorCal Sierras, Stan's NorCal 40, a Ten Tec Argonaut 505, a Ten Tec Scout (set for QRP), and a Kenwood TS-50 (also set for QRP) were used on HF. Eric also set up a packet station on 2 meters, and we had several 2 meter simplex voice QSOs. In spite of soaring temperatures, hordes of mosquitos, a little poison oak, and a less than stellar score, Field Day was a great success for all of us. We can hardly wait 'til next year!
72, Stan, K4DRD

Grounding and Random Wires

By Jay Coote, WB6AAM
P.O. Box 3131
South Pasadena, CA 91031
JCoote@aol.com

What do I think of random wires?... hmmm, this will be a long one. Be patient.

Length:

There is too much fuss about length. If the antenna is around 1/4 to 1/2 wavelength at the lowest freq, it will work effectively on that and all higher bands. Old ham texts about 67' or 134' of wire date back to the 1930's and 40's when the PA tank circuits connected directly to the antenna (no coax). The antennas then had to be specific lengths. 50-60 years later we have NINE bands and tuners. Whatever length works with your tuner on all
nine bands is "the" length.

Antenna pattern:

A random wire will probably be used in temporary, concealed or other less-than-perfect sites where ground or nearby objects interfere with the pattern. In the clear, a straight horizontal wire run will behave similarly to a horizontal dipole. If the length of a straight random wire is several wavelengths, lobes develop off the ends of the wire. The longer the wire at frequency, the more directive off the ends. Random wires many wavlengths at
frequency are called longwires and have been used for their directive properties. A typical random wire, 50' to 150' in length and 30' above ground will generally have medium and high-angle properties on the lower HF bands; high and medium angle properties on the high HF bands. I have also deliberately kept wire antennas below 30' above ground for high-angle work (NVIS) on 1.8-7 MHz.

Portable/Emergency/Concealed use:

The random wire lends well to these operations because there is only a single, thin conductor to deal with (no coax or balanced line). The antenna may be thrown over roofs or trees. It may be dropped from a high-rise balcony. It may be shaped like "V", "L", "sloper" or other antennas with similar performance. The random wire requires fewer supports than coax-fed or balanced antennas.

Ground or Counterpoise:

The random wire must be operated "against" a ground or counterpoise. (You wouldn't feed just half of a dipole). Hams have to remember that the counterpoise for a random wire is like the "opposite leg" of a dipole...it should be treated as a radiator. Large ground rods in the earth may be suitable for VLF or lightning protection, but are not as efficient at HF. (Compare a dipole to a 1/4 wave vertical with a ground rod). The length of the counterpoise wire (s) may be whatever works with your tuner and antenna on all nine bands. Some people will use a 1/4 wave radial for each band which produces a "hot" tuner chassis. Some have used a counterpoise which lies under the length of the flat-top portion of an L-shaped random wire. The counterpoise under the antenna is said to improve on high-angle work by acting a little like a reflector in a beam antenna.

A few hams have used an MFJ "Artificial Ground" which is simply a series L-C tuner connected between the GROUND terminal of the tuner and the counterpoise. It is said that tuning the counterpoise keeps RF off the chassis and may improve the radiated signal. With the antenna up and in place (especially a concealed antenna) it may be easier to play with the counterpoise length to get the system to work on all bands.

Drawbacks of random wires:

In some concealed and temporary installations, part of the antenna will be indoors or will run close to the plumbing, wiring, utilities or metal mesh in the building. In comparison, a center-fed antenna and TV or ladder-line will get most of the radiating portion of the antenna up and away from the building.

Tuners for random wires:

Most ham tuners for sale, or magazine projects are variations of the T-network. With sufficient L and C, the tuner should cover 1.8-30 Mhz with a few tries at finding a wire and counterpoise length. Useful L might be 0-25 uH. Useful C might be 0-200 pF. Some poor tuner designs don't have the L/C to load a random wire, let alone a dummyload under 7 Mhz. Another good tuner which is very easy to build is the L-network. The L uses a series inductor and a shunt capacitor at the output. You don't have to isolate the cap, as it's case must be grounded to chassis. I once built an L-tuner for QRP-CW out of a 360 pF variable cap and tapped inductor.

Bottom line:

Disregard ancient texts about exact length. With your tuner, a 110' wire will work as well as a 140' wire. Experiment with antenna and counterpoise length. Treat your counterpoise or radial(s) as a radiating part of the antenna rather than an electrical ground. I am in a temporary location and I am presently using a 120' to 140' (who's measuring?) wire about 20' average height above ground. The tuner is an MFJ945D and I have also used my homemade L-tuner. My ground is a water pipe (boooo!). It's not a DX blaster antenna but I can make contacts on ALL bands.

72 Jay, WB6AAM (ARCI 5050)

Transceiver Alignment and "What does it mean Alfie?"

By Chuck Adams, K5FO
9814 Limerick Dr.
Dallas, TX 75218
adams@sgi.com

Let's talk about several related things — transmitter and receiver frequencies. These two may or may not be the same at any time or at all times and then again they may be the same all the time. Confused? Good, then I can help you out.

First of all lets look at a transmitter or signal source at some freqency within amateur bands and let us call it f(0), where the f(0) will be f-sub-zero or f-sub-naught depending

upon your view in the fine art of mathematics. I'm limited in this article by typing things in ASCII so I will be using some notations that would be much simpler with subscripts. So for the sake of discussion, let f(0) be 7.040MHz. If the transmitter is on and it is a pure sine wave at f(0), we might plot a frequency spectrum graph like:

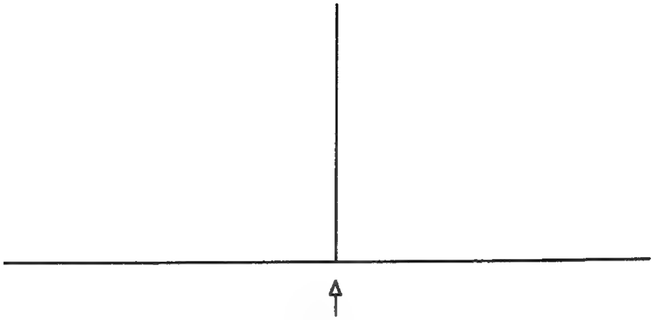


Fig. 1

where the height might be proportional to the amplitude of the received signal in a receiver. Here we are not concerned with the strength, just that it exists and we can hear it on our transceiver. Now the above graph means that we are emitting only 7.040MHz and no other frequencies; no second harmonics, third, or N*f(0) where N=2,3,4,... An ideal case, but understandable.

OK, let's look at the receiver signal chain, simplified for a single conversion superheterodyne. The signal comes into the front-end and goes through the first mixer where we have a LO (local oscillator) that varies over a range for say 50 KHz. Let its frequency be f(1). We will get out of the mixer the frequencies f(0)+f(1) and f(0)-f(1) and some other stuff, but we are interested in only one of these and this is how we home in on what we want. We use a filter after the first mixer, called an IF filter, because we are going to get an Intermediate Frequency between the two we are mixing (usually). Let's take the IF to be 4MHz for two reasons; 1. it makes the mathematics simple and 2. we can buy some real cheap crystals (but not too cheap) at this frequency.

What we want is f(0)-f(1) to be 4 MHz. f(1) is called the VFO (variable frequency oscillator), so if we want to listen to the transmitted frequency at 7.040MHz then the VFO must be at 3.040MHz to give us f(0)-f(1)=7.040MHz-3.040MHz=4.000MHz. We will also get f(0)+f(1)=10.080MHz, which we don't want and gets eliminated by the IF filter following the mixer. We now have moved our received signal to another frequency range internal to the receiver and we start to do stuff to it. We probably want to amplify it using an IF amplifier, say a MC1350.

Our spectrum graph may now look like Fig. 2 (I won't go through all the gory details of relative strengths of each of the resulting components I'll save that for another 100 pages later on.)

At this point and time none of us can use the 4.000MHz signal to hear anything. We need to get it to an audio range, so we pass it through another mixer, which we will call a detector, because it will allow us to "detect" the signal, i.e. hear the signal as an audio tone. So what we have is another mixer with a LO, but this one will not vary in frequency.

Let's say you like to hear CW at a tone of 600 Hz. We will make this LO 3.999400 MHz. The output frequency from the mixer will be f(2) - f(3), where f(2) is the frequency through the IF filter into the detector and f(3) is the LO frequency of 3.999400 MHz. Thus 4.000000 MHz - 3.999400 MHz = 600 Hz.

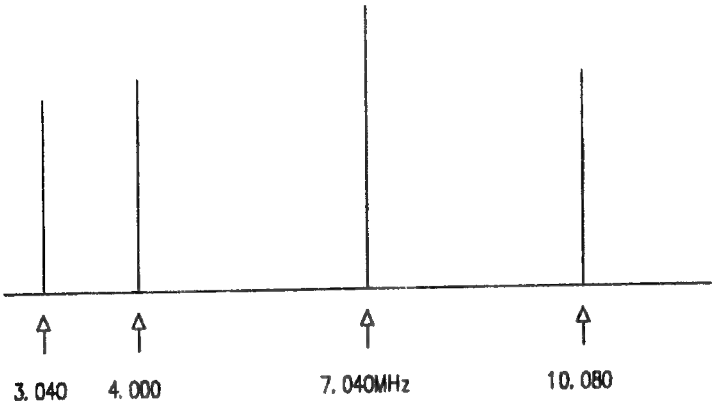


Fig. 2

This we will pass on to an audio amplifier, say a LM380 or LM386. The diagram would look like Fig. 3.

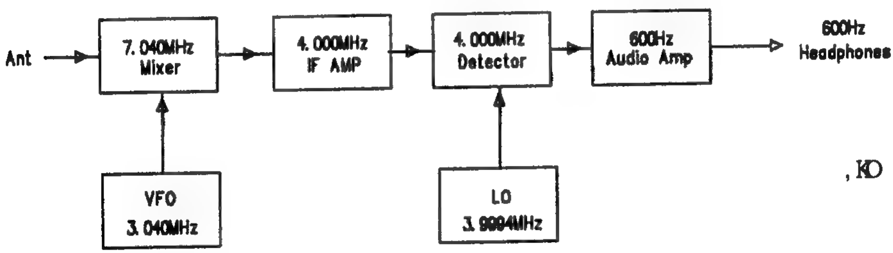


Fig. 3

There are a lot of transceivers out there with setups similar to this, but different frequency combinations and I leave it up to the reader to investigate what you have and what frequency combinations the designer used. The process of mixing two signals (a.k.a. heterodyning) to get another frequency is what makes superhets work. We can play all kinds of games with the VFO frequency and LO frequency and get the same results, but let's save that for another article. OK?

Another thing in the background that makes this work relatively well is the filters that exist in the front-end stage, usually at the antenna, the IF filter just before the IF amplifier stage, and maybe even a builtin audio filter. There all kinds of nasty critters (other frequencies) that mix and also give us 4.000MHz and thus 600Hz out and we will call these critters "birdies". They sing to us and we don't want to hear them.

As another example: if you have a local AM station at 960KHz, then that station

combining with 3.040MHz VFO frequency will yield a signal at 4.000MHz and we will hear a 600Hz tone. Hopefully the RF filters between the antenna and the first mixer (the front-end section of the receiver also called the RF section as we are dealing with RF frequencies) will filter out the AM broadcast station. Ever hear someone else (I hope this isn't a problem with you) say that they are having interference problems from a local broadcast station? Could be this type of problem.

Now I want to show you one other thing. Reach up and turn the tuning dial on "our" receiver. Let's say you move it down 200 cycles. This would mean the VFO frequency would now be 3.039800MHz and we would get 7.040000-3.039800=4.000200MHz out, which most likely will pass through the IF filter and the detector would output 4.000200-3.999400MHz=800Hz, which is what we would expect. The transmitted frequency did not change. We changed the "receiver" frequency by varying the VFO. We now hear in the earphones (speaker) a tone of 800 Hz, i.e. it increased in frequency. This is what we would expect from the above example. If we tune down in frequency and the tone that we hear in the headphones or speaker goes up, this usually means that the VFO is lower in frequency than the received signal and the IF frequency is between the two. We can come up with other frequency combinations that go the other way. There are many design considerations that will determine what we use. Most critical is stability in the VFO, and the lower in frequency it is, the easier to eliminate drift, but we don't want to go too low. Most VFOs in transceivers are between 2 and 5 MHz for this reason. To go higher in VFO frequency and keep stability and eliminate drift increases the difficulty in designing and increases the cost of the components to do this.

Something to consider. The IF filter, usually a lattice of crystals, does not pass frequencies at 4.00000MHz, but a range of frequencies to one side, either the lower or the upper side depending upon whether we want USB or LSB range of frequencies. Think of the IF filter as passing some range of frequencies, say 4.00000 to 4.000600MHz for a 600 Hz filter. We want the LO at 4.00000MHz to receive LSB in our example above. If I set the LO at 4.000600MHz, then I'll receive USB, and here again in order to save space I'll leave it as an exercise for the reader to show how this works. Not difficult at all. This why the tuneup instructions for your kits show how to align the LO in the detector circuit. If I set the LO to 4.000300MHz, I'll hear both sidebands, but only up to 300Hz either side. If you have a superhet receiver and you can tune through a signal and hear the opposite sideband, then you need to go back and recheck the tuning for the LO in the detector circuit after the IF filter.

So now you understand why the tone in your earphones changes when you reach for the tuning dial and tune across the band. The math wasn't all that bad, was it? Those long hours in high school algebra are now starting to pay off. I can show the trigonometry too for the mixer, but let me save that for another time and place.

OK, now we tune back to 600 Hz in the ears, and we are now ready to work this station. Say he/she is calling CQ. We fire up the keyer and get the paddles/key in hand ready to pounce. When the station finished we start with what will hopefully result in a two way QSO. We start sending —— wait just a minute, hold your horses! How in the world do you know you are transmitting on f(0) too? Well, this is where the transmitter alignment comes into play.

If your receiver VFO also controls your transmitter frequency, which is most cases in modern QRP gear, then we need to make sure that it outputs the right frequency too. The transmitter usually looks like Fig. 4.

This diagram assumes a lot, i.e. the VFO frequency is really 3.040MHz and the LO is at 4.000000MHz. Maybe they are and maybe they are not. I will discuss how we align all this up in a later section, but let me give you an exercise.

Dig out your 1995 ARRL Handbook and look in Chapter 17 for Dave Benson's NN1G transceiver. Figure out what part of each circuit corresponds to the diagrams in this article. Figure out the IF frequency for each band and the VFO freqs. Do you see how the differences in frequencies interplay? I knew you could. Now here is how we adjust.

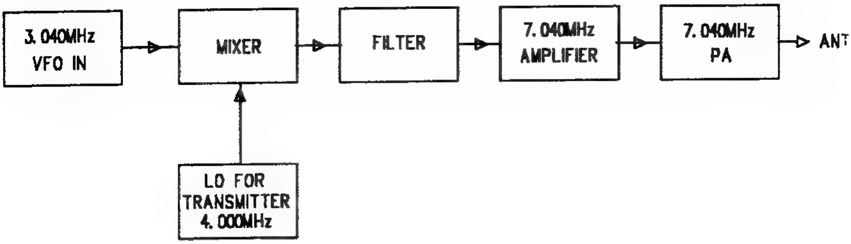


Fig. 4

First of all, we need a combination of three things and let's just start out with two transceivers and one receiver. The two extra rigs we need to calibrate our rig. I'll show later how we can do the same thing with a generator and a frequency counter with the transceiver. For now, one transceiver we will use to transmit on 7.040MHz. We listen for it on both our transceiver on which we are doing the alignment and the other receiver. This latter receiver is used to keep us honest. We cannot trust the alignment on the transmitting rig, even if it costs $3,000, and I mean it. Just because it costs an arm and a leg doesn't mean that it is perfect. This also may be the same reason that we sometimes call someone and they never come back to us even though we know we are on frequency. OK, we transmit on transmitter one, T(1) on frequency f(0) and we listen on the receiver, R. We now know where the signal source is and when we transmit with our transceiver that we are aligning we will know if we are in sync, i.e. transmitting on the same frequency.

We now take our transceiver and tune in f(0) until we tune in and hear the frequency that we like to hear. This varies from person to person (remember this and it is important). OK, key down. How do we know where we are transmitting? We listen in the receiver. We may have to tune around to see where we are, but hopefully we are close. We then adjust the LO in the TRANSMITTER of our transceiver until we get 7.040MHz out. Most rigs will have a variable trimmer cap on a crystal oscillator circuit that will allow us to adjust the resonant frequency near where we want to be. We will know where this is by listening to both our signal and the signal from the other transmitter and getting them on the same frequency. Don't move the dial setting on the original transmitter or on the transceiver that we are aligning. You don't want to have the key down on any transmitter for very long. Do short bursts between the two. When you are sure that you are transmitting on the same frequency as the reference transmitter when you are receiving the signal at the note that you like, then you are done. Move the transmitters around and try this on other frequencies to make sure your alignment is correct. OH, you are doing this with dummy loads on both transmitters? I knew you were.

You can do this with a steady signal generator instead of a transceiver and you can use a digital frequency counter instead of another receiver, but you have to be careful not to overload the counter and of course, we are working all transmissions into a dummy load from the start. Do not do this into an antenna. The rest of the world will not appreciate it at all.

With the counter, you measure the output of the signal source and then the output of the transmitter in the transceiver when you are receiving the signal source in your receiver at the desired comfortable tone you are used to.

Now, do you know why we do this in the above manner? Well, you can't trust another transceiver (unless you set it up) to have its receiver tuned to the exact frequency that it is transmitting on. Have you ever had this happen? You hear someone transmitting and you give them a call and they don't come back to you. There may be several reasons for this: 1. you are too weak, 2. they hear another stronger station, and 3. they just might not be listening on their transmit frequency. They just might have RIT on and have forgotten about it. Sometimes the rigs come from the factory misaligned. Yes, I know it's just too hard to believe, isn't it??? When is the last time you checked out a rig to see if it is on track? You might be surprised.

After reading this and if you have the time and equipment to do so, test this article against your rig and see if it is aligned properly. You will need and will have to understand the schematics and the operation of the rig you are testing.

Good luck and I hope this article has furthered your knowledge of transceivers, receivers, and communications in general.
dit dit 72, Chuck Adams K5FO CP-60 adams@sgi.com

Directional Power Meter

By Jim Pepper, W6QIF
44 El Camino Moraga
Orinda, CA 94563

In the days when the only method of generating RF power was the vacuum tube and Ham transmitters were best if they resembled AM broadcast stations, the concern for standing waves and reflected power was of little concern on the HF bands. Antennas were primarily of four types, a half wave either centered or end fed with open wire (600 ohm) line, an off center fed with a single wire (later called a Windom antenna), and an end fed called a Marconi type of various lengths. Co-ax had to wait till after WWII to be used.

All of these antenna types required an antenna tuner. The common method to determine whether the antenna was taking power was through the use of an RF ammeter, a neon lamp or a pilot lamp in series with the feeder line or lines. Losses in the feed line as a result of a mismatch were so small that they were ignored.

In the late sixties and seventies the use of transistors as RF power generators were starting to be found in amateur equipment. Their low output impedance allowed broad banding with out the necessity of tuning the output stage of the transmitter. However their efficiency depended on having the load match the designed output impedance of the RF stage. Transistors were not as forgiving as vacuum tubes to a mismatch and therefore required more attention to the use of an antenna tuner. To help in obtaining a good match, the directional power meter or SWR meter came into use. The sole purpose of the tuner is to provide an impedance match at the end of the feeder line to best match the transmitter output impedance. One can still have a high SWR on the transmission line but the power will still be radiated. The main problem is in the power loss in the transmission line. The loss is affected by three main factors, the length of line, the type of feeder line and the frequency of operation. For ham bands from 160 to 20 meters, the loss due to a high SWR is negligible if the transmission line is not excessively long. For an end fed Marconi there is no transmission line and therefore no loss, yet a tuner is required.

Mismatch takes place in two areas, the point where the feeder connects to the antenna and where the feeder connects to the transmitter. Through the use of a tuner we can

obtain a good match to the transmitter but the mismatch at the antenna depends on a number of things.

First is the impedance of the transmission i.e. 50 ohm co-ax or 600 open wire line. Secondly, the type of antenna. The center of half wave doublet antenna has what is called the radiation resistance that is around 70 ohms. This resistance depends on the height above ground and ground conductivity. For an end feed, the resistance and reactance can either be high or low depending on its length. If there is a mismatch, a cetain amount of the radiated power will be sent back down the line. If this reflected power sees a match at the transmitter end, it will be re-radiated back up the line where part will be radiated and part will be again reflected until reduced by the loss in the line.

To put it a few simple words, if you use a tuner that matches the feed line impedance to the transmitter on the lower frequency bands, there is no need to match the transmission line to the antenna because almost all of the power will be radiated. In addition, pruning the length of antenna or feed line is a waste of time. Remember, all of this is based on using a matching tuner otherwise all bets are off. Of coarse you can use a center fed doublet with 50 or 75 ohm co-ax and not require a tuner because the missmatch would probably never be greater than 2 to 1 as long as the transmitter can handle this amount. But in addition, the matching device also provides harmonic filtering when used which makes its use advisable.

Matching the Feed Line to the Transmitter

The tuner must be so designed to cancel out the reactive component of impedance that appears on the end of the transmission line for either a balanced or unbalanced line. Since most of the QRP work is done with an unbalanced line, this simplifies the design. This is where the directional power meter comes into play. Through its use, the tuner is adjusted to give minimum reflective power vs maximum forward power, thus providing the correct match to the transmitter.

Directional Power Meter

Figure 1 shows the schematic for a directional power meter that can be used for unbalanced or balanced lines with a tuner. The power meter is placed between the transmitter and the tuner. The circuit in this case uses a bar graph presentation rather than two meters for the forward and reverse power. The space required is much less than for two meters and the cost is less.

Since it is normally used only when initially tuning up, the power can be turned off when no longer required. A 9 volt battery works very well or you can derive power from your transceiver.

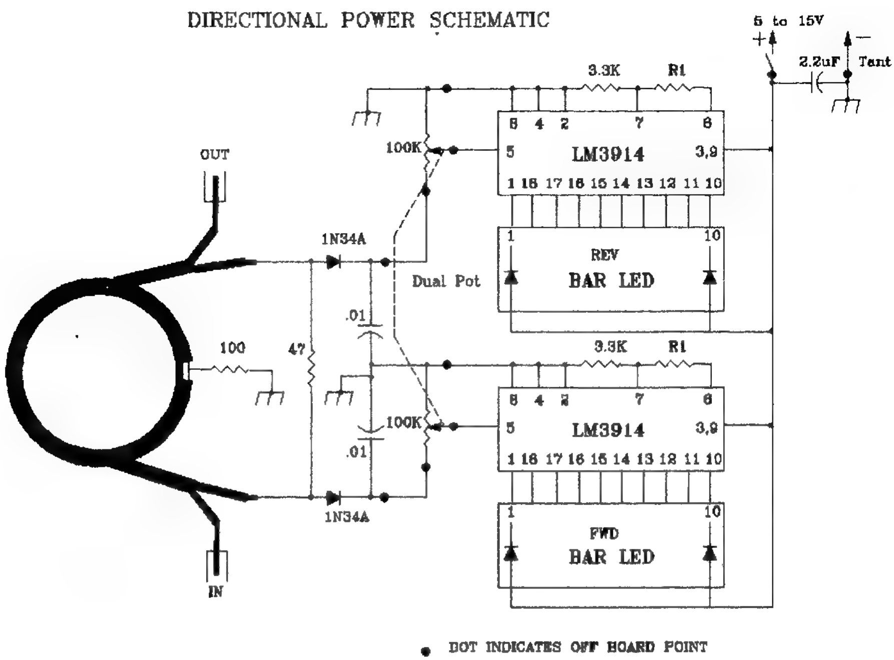
The current required when in standby is approximately 15mA, and with 10 segments on, it is about 50mA. The LED current is controlled by the resistor between pins 2 and 7. It might be a good idea to put an LED in the battery circuit to tell you when the power is on or off.

An LM3914 is used as a voltage to LED level indicator. The LM3914's sensitivity can be controlled by a resistor between pins 6 and 7. I found a value of 82K provides enough sensitivity for 2 watts or more. Increasing the value to 100k should prove satisfactory for lower powers.

The dual potentiometer is used to set the forward level to ten segments on the display. It will have to be readjusted as you go through the tuning procedure. The end result is to have a maximum on forward and a minimum on reverse. The two may not coincide but they will be close enough to indicate a matched condition.

I found, rather than using coils or coax for the line transformer, that "ZIP cord" used for appliances could be used with very good results. This would not be true in the VHF region but is perfectly adequate for the 160 to 20 meter bands. I compared the results

with a SWAN directional power meter and the comparison was quite favorable. One leg of the ZIP cord goes from input to output and the other goes to the metering circuit. This



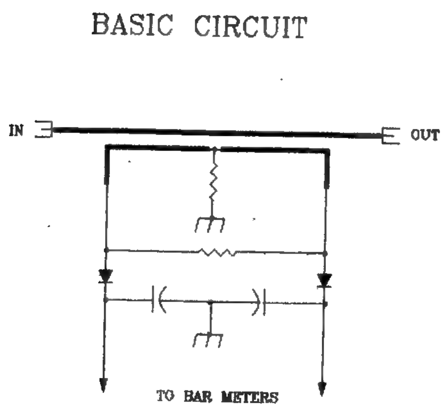


Fig. 1

leg is tapped at the center and connected to ground through a 100 ohm resistor. I wound the ZIP cord in the form of a circle to occupy less space since the size I used was ten inches long. If you only want it for 40 and 30 meters, the length could be reduced if you have sufficient sensitivity to give full scale on the bar graph.

Figure 2 shows a simple tuner that I use to tune my 250 end fed long wire for 40 and 80 meter operation. The capacitor can be switched from the input side to the output side to accomodate various lengths of antennas. For co-ax operation, the coil should be shorted out. For short endfed antennas, either a ground or counterpoise must be used.

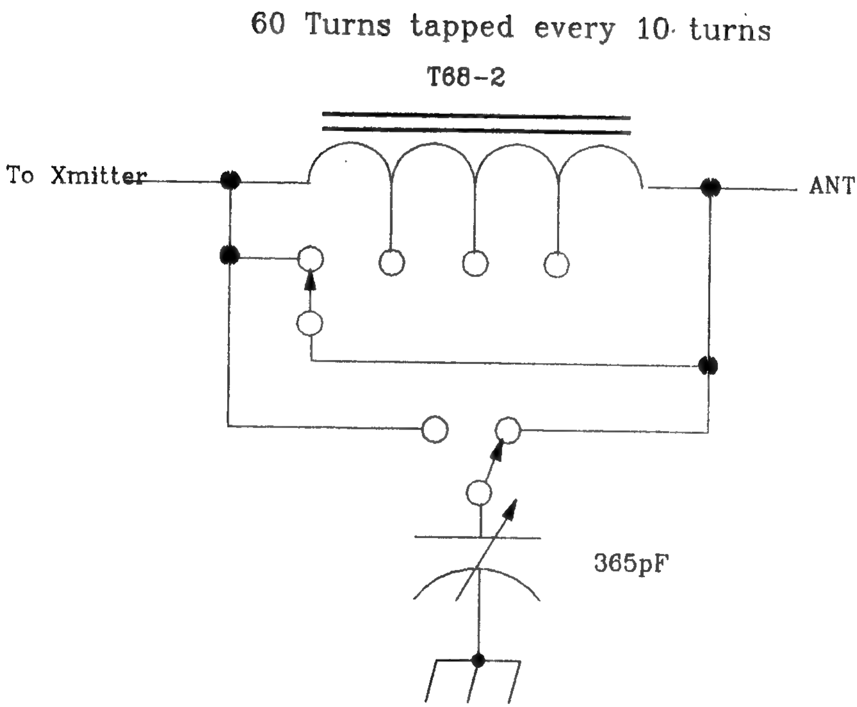
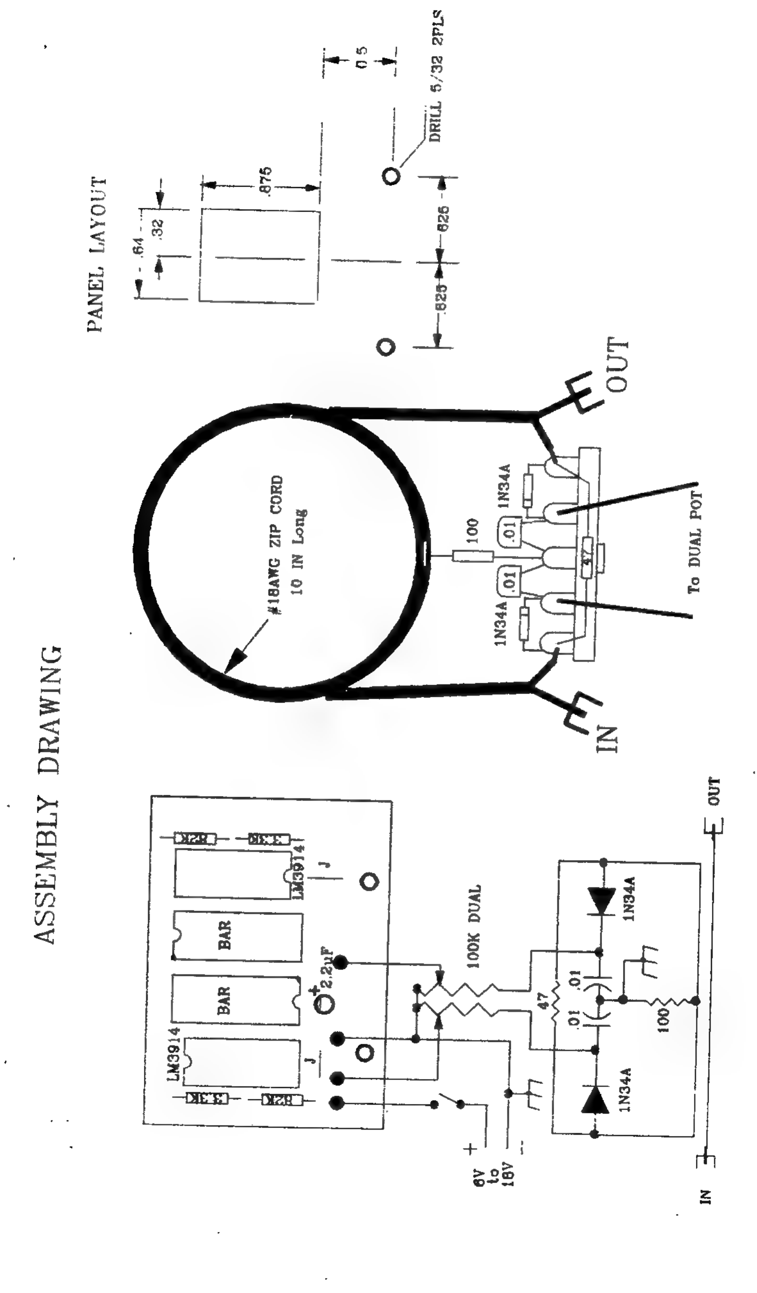


Fig. 2


ASSEMBLY DRAWING
PANEL LAYOUT
.64
.32
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DRILL 5/32 2PLS
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#18AWG ZIP CORD
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1N34A
1N34A
To DUAL POT
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IN
82K
3.3K
LM3914
J
BAR
BAR
2.2uF
LM3914
J
3.3K
82K
100K DUAL
6V
to
16V
+
-
47
.01
.01
100
1N34A
1N34A
OUT
IN

Fig. 3

Figure 3 shows the parts layout for the pc board that can be obtained from FAR Circuits. See parts list for cost and address.

I used 20 pin sockets to mount the Bar graphs and 18 pin sockets for the LM3914's. The LM3914 has a small bevel edge that indicates pin number 1. Note that the forward and reverse circuit are inverted one from the other. This allowed the forward reading to go up and the reverse to go down.

In Conclusion, there is no need to worry about the SWR on the transmission line on the lower frequency bands as long as the transmission line at the transmitter is matched to the output of the transmitter with a tuner. The loss will be negligible.

I also wish to thank Eric Swartz (WA6HHQ) for taking the time to check out my project and giving his stamp of approval.

Parts List:

	Part	Needed	Cost	Ext.	Source
1.	LM3914	2	$2.75	$5.50	DC Electronics
2.	Bar Graph, ME351-2411	2	$3.50	$7.00	DC Electronics
3.	Dual Pot (31VW501 100K)	1	$2.00	$2.00	DC Electronics
4.	PC Board Dir-Pwr-Mtr 401C	1	$5.50	$5.50*	Far Circuits
5.	.01 Disc	2			
6.	2.2uF/16V Tant.	1			
7.	82K 1/4W	2			
8.	3.3K 1/4W	2			
9.	47 ohm	1			
10.	100 ohm	1			
11.	SPST Switch	1			
12.	9V Batterey	1			
13.	1N34A	2			
14.	20 Pin IC Socket	2			
15.	18 Pin IC Socket	2			
	Misc. Hardware and Cabinet				

Note: it is possible to obtain the LM3914 ($2.00) and Bar graph ($1.96 #DC10EWA) from Circuit Specialists but they don't have the dual pot. 25K to 100K ok. If you can find this locally then you could save some money. Both DC Electronics and Circuit Specialists have a minimum shipping charge of $4.00 but no sales tax for outside Arizona.

Circuit Specialists	DC Electronics	Far Circuits
PO Box 3047	PO Box 3203	18N640 Field Ct.
Scottsdale, AZ 85271	Scottsdale, AZ 85271	Dundee, IL 60118
		*Includes Shipping

Prices are subject to change. Note that the Bar Graph display can be enhanced by placing a red transparency in front of the display. One can obtain this material at a variety store. It is used as part of report binders.

72, Jim W6QIF

Reading Material:

ARRL Handbook Chapter on Transmission lines
QST April, June, August, October 1973 "Another Look at Reflections" by M. Walter Maxwell W2DU/W8KHK
Aerials II by Kurt N. Sterba Worldradio publication.

My NorCal Sierra Experience

By Bill Shanney, KJ6GR
19313 Tomlee Ave.
Torrance, CA 90503

I was very happy to receive my Sierra QRP Transceiver kit during the long Thanksgiving weekend. I wasted no time getting started, the main board was completed over the weekend and the 40 meter plug-in band module was finished during the following week. The rig put out 2 watts on 40 and I received many complements on the keying quality. The 80, 30, and 20 meter band modules were completed in one more week and I was disappointed with the results. The output power/band measured 2.5W/80M, 2W/40M, 1W/30M and 0.5W/20M.

I went through the signal tracing routines described in the "Troubleshooting" section of the Owners's Manual and found an inconsistency between my power reading and the output voltage which I happily discovered was due to a bad coax cable. A new cable brought the power on 20 up to just over 1 watt. I had a telephone conversation with Wayne, N6KR, read his article in the December QRPp and was ready to start modifications. The following is a list of my changes and their outcomes.

1. I changed C69 to 39pF, no change in output power noticed.

2. I rewound T2 with an 18T primary and a 5T secondary, the power output dropped on the lower bands. I changed the secondary to the original 2T and the output power was up a little on all bands. I eventually tried changing the primary to 15T but saw very little change.

3. I changed R15 to 100 ohms and the power went up a bit on all bands.

4. I noticed that about 25% of the signal was being lost in the low pass filter on the higher bands. I changed C47, 48, and 49 to silver mica types as suggested and the power came up considerably. I changed the caps on the 40, 30 and 20 meter modules.

5. I replaced the output PA transistor with a MRF-237 and picked up some more output on 30 and 20 meters.

The low pass filter capacitor change and the R15 change had the biggest effect and I think would have satisfied my desires if I tried them first. I now have a very respectable power output/band of 3W/80M, 3W/40M, 2W/30M and 2W/20M with the drive adjustment backed off to slightly less than 90%.

I really enjoyed building and modifying my Sierra. Wayne, N6KR and the NorCal Club are to commended for an outstanding project. While waiting for the kit to come I built a W7EL QRP SWR meter, an A&A CMOS keyer, several antenna tuners and a multiband offset fed dipole which, together with the Sierra, fit in a plastic tool box to make a fine portable setup.72, Bill, KJ6GR

OPTIMIZED SIERRA OUTPUT-FILTER VALUES

By Dave Meacham, W6EMD
206 Frances Lane
Redwood City, CA 94062
DMM@aol.com

Want to tweak your Sierra output circuit to the max? Here's how! Simply use the nearest standard capacitor values and inductor data shown below. Note that the 20-meter values do NOT need to be changed.

NORCAL SIERRA OUTPUT-FILTER VALUES

FILTER COMPONENTS THAT EQUAL 50 OHMS REACTANCE AT HIGH END OF RANGE

High End		L5&L6	C47	C48	C49 Nearest Std. Cap. Values
1.95MHz	4.08uH	1633pF	3266pF	1633pF	1600, 3300 (3300 Stock)
3.65	2.18	873	1745	873	910, 1800 (1800 Stock)
7.15	1.11	445	891	445	430, 910
10.15	0.784	314	628	314	300, 620
14.15	0.563	225	450	225	220, 470 (Stock OK)
18.15	0.439	176	351	176	180, 360
21.15	0.376	151	301	151	150, 300 (150 Stock)
24.95	0.319	128	255	128	120, 250
28.15	0.283	113	226	113	120, 220

NEAREST INDUCTOR VALUES

1.95MHz (4.08uH)	4.10uH, 32T. on T37-2 core
3.65MHz (2.18uH)	2.19uH, 27T. on T37-6 core
7.15MHz (1.11uH)	1.08uH, 19T. on T37-6 core
10.15MHz (0.784uH)	0.784uH, 14T. on T37-2 core
14.15MHz (0.563uH)	0.576uH, 12T. on T37-2 core (Stock Sierra OK)
18.15MHz (0.439uH)	0.432uH, 12T. on T37-6 core (Stock Sierra OK)
21.15MHz (0.376uH)	0.363uH, 11T. on T37-6 core (Stock Sierra OK)
24.95MHz (0.319uH)	0.324uH, 9T. on T37-2 core
28.15MHz (0.283uH)	0.275uH, 8T. on T30-2 core

If the stock Sierra caps mentioned above are within 5%, then only the following additional caps are needed:

2-1600pF, 3-910pF, 2-430pF, 3-300pF, 1-620pF, 2-180pF, 1-360pF, 4-120pF, 1-250pF, 1-220pF.

Cores needed: 2-T30-2. (Use 12 and 10 meter T37-6 cores on 80 and 40)

Note: Silver-mica caps come in the widest selection of values. Polystyrene caps are next. Monolithic caps have more loss but will work.

Have fun! 72, Dave, W6EMD

VARIABLE-POWER CAVEAT

By Dave Meacham, W6EMD
206 Frances Lane
Redwood City, CA 94062

On many QRP rigs the output power is adjustable. Each rig, however, is usually designed for a SPECIFIC power level. There are good reasons for this, as I will explain.

The function of the output filter in a QRP rig is to attenuate (reduce) harmonics because the PA (power amplifier) output is not a pure sine wave (in fact, many PA's produce output very rich in harmonics). Output filters are designed for specific terminations (source and load resistances), usually 50 Ohms. If the load (antenna) or source (PA) does not present 50 Ohms to the filter the result is more harmonic output and possible spurious emmissions from the PA. I have personally confirmed such results by observations using my spectrum analyzer.

I'm sure most QRP operators are aware of the importance of having a good 50-Ohm

match at the antenna terminal of the rig (the filter output). Not as well known is the need for a 50-Ohm match at the INPUT to the filter.

Providing the proper load for the transistor PA gets complicated at VHF and above. For HF operation, though, we are usually safe in assuming that the proper resistive component of the load should approximate the collector-voltage squared, divided by two times the power. So for 14 Volts and 2 Watts, RL=196/4=49 Ohms. With a 50-Ohm load on the output of the filter, and 50 Ohms presented to the PA, everything should be fine at 2 Watts.

What happens if you "turn up the wick" to 4 Watts? Well, now the PA wants to see 196/8=24.5 Ohms. Since the filter is still presenting a nice 50-Ohm load for the PA you have a 2:1 mismatch! The same situation would occur if you turned the power DOWN to one Watt (196/2=98 Ohms, again 2:1). Either way the result is a bad load for the PA and a bad source for the filter. Solutions for this problem (at a specific power level) include using a transformer or a matching-type of filter.

Component values (active and passive) vary quite a bit. Therefore, performance varies from rig-to-rig. Designers recognize this and sometimes include a control to vary the power (drive control, etc.).

If your radio has such an adjustment, think of it as a way to compensate for transmitter-component values that are not on the money. Then use it to set the output power to the design value.

My admonition is: If your QRP rig is a 2-Watt radio, run it at 2 Watts! 72, Dave, W6EMD

Oscillator Designs With Varicaps

by Jim Pepper, W6QIF
44 El Camino Moraga
Orinda, CA 94563

To my knowledge there has been very little information in amateur publications as to how to calculate the controlling frequency elements for the standard oscillators used in home brew amateur equipment. The normal approach is to use the cook book method, to use what other people have used as their design criteria. I decided to take a little time and develop some of the equations for the Hartley, Colpitts, and Clapp oscillators in conjunction with the use of Varicaps as tuning elements. I was particularly interested in the Hartley circuit but decided to do it for all three to see what the comparison was especially when tuned by a Varicap.

The Varicap has been used quite often but on a sort of hit or miss basis to get the right value. There are a number of things about the Varicap or some times called a Varactor diode that should be considered.

1. They are temperature sensitive

2. The capacitance variation as a function of the applied voltage is very non linear. The greatest change takes place at the low voltage end.

3. They come in various min/max values but the minimum does not approach that of a mechanical capacitor.

4. As the temperature increases, the capacitance increases causing the frequency to go down.

5. It is not wise to use Varicaps as the only source of controlling capacitance for frequency selection because of their temperature problem.

6. For proper operation, a positive voltage is applied to the cathode rather than the anode.

7. They do have some advantages: they are small, they are inexpensive, and because their capacitance is changed by varying an applied voltage to the device, precision tuning can be achieved using a ten turn potentiometer as the voltage control. With a mechanical tuning capacitor with a reduction gear ratio of 8:1, the dial only rotates 4 turns for 180 degrees of the capacitor tuning.

8. Some of the Varicap ranges available are:

MV2109 33pF @ 4V rev bias
MV2115 100pf @ 4V rev bias
MVA109 450pF @ 1V rev bias
NTE618 440pF @ 1V rev bias

So, how can these Varicaps be used? They can be used as band spreading capacitors allowing the tuning of a small frequency range such as covering just the ham band. For example 7.0 to 7.3 MHz. In the three examples I have shown how to calculate the required components to give the required ranges. One must understand that these equations give you a starting point since there are other variables that come into play such as circuit capacitance and component tolerances.

In my examples, except for the Colpitts circuit, in order to keep it simple, I didn't bring in the minimum capacitance of the Varicap which will modify the inductance required at the upper frequency. One can add about 10% to the chosen value for C2 pF, the fixed capacitor in the frequency determining circuit. I also made the assumption that C3 and C4 are equal in value which is the common case. In the case of the Colpitts, I also assumed a value for the capacitor designated C5 making it equal to .5 C3.

The first thing that must be chosen is the value for C2. It should be as large as possible to give a high C/L ratio. On the other hand, if C2 is too large, the Varicap may not be able to add enough capacitance to it to provide the additional range.

In all cases the FET was an MPF102 operating with 5 volts on the drain. (For those unfamiliar with an FET, the drain is like the plate in a vacuum tube , the source is like the cathode and the gate is like the grid.)

The Hartley Circuit

The Hartley uses the least number of components of the three. It does require a tap be made on the coil but its position is not too critical to make it oscillate. More about this later. It also required the least amount of capacitance variation from the Varicap to achieve the same tuning range. The object is to determine the value of C1 to give the range desired for a given range for the Varicap diode capacitance. It must be noted that the required additional capacitance CA required to tune the lower frequency edge must be less than or equal to the maximum value of the Varicap. The object is to use the least amount of Varicap change to achieve the desired range. The value of the coil for the Hartley is considered to be made up of three inductances L1, L2 and 2M the mutual inductance between L1 and L2.

When solving for the value L for the actual coil to be used, the value developed from the equation must be reduced by the value for the mutual inductance. I have chosen this to be 10% of the calculated value of the coil.

The procedure to follow is:

1. Chose a value for C2, the fixed value capacitor for the tuning circuit.

2. Next, calculate the inductance necessary to tune this circuit to the upper frequency desired.

3. From this value of L, calculate the capacitance necessary to tune the lower band edge desired.

4. Subtract the original value of C2 from this number. This gives the required additional capacitance to tune the lower edge. I called this capacitance "Ca".

5. Chose a Varicap capacitance type that is greater than this value. I usually subtract out 10% from the maximum value to reduce the non-linear portion of the Varicap.

6. Solve for the coupling capacitance C1 to give the required range.

7. Solve for the value of the coil L (Note: a good source for determining the number of turns required to achieve the required inductance can be found in Vol 1, Number 3, Dec 1993 of the QRPp journal, page 42, by WA8MCQ

You will note in all of the circuits I have included a fixed resistor in the upper and lower portion of the ten turn tuning pot. The lower one prevents the reverse voltage from going to zero where the Varicap is very non-linear. This voltage should be about 1 volt or greater. The upper resistor limits the upper frequency. These resistors could be made variable to set the upper and lower frequency points more precise. R3 is used to further linearize the capacitance change. A typical value is about .5 of the ten turn pot value. Such a technique can make a linear pot into an audio taper pot as well.

The Colpitts and Clapp Oscillators

These two oscillators are basically the same relying on C3 and C4 for the feedback. The procedure for calculating the component values are the same as for the Hartley. The Colpitts requires the most capacitance for a given tuning range. The Hartley the least.

Temperature Compensation when using Varicaps

You will recall in the early part of this article I mentioned that I would talk about the tap on the Hartley. During my experimentation with the Hartley, I accidentally found that changing the location on the tap would change the tempco of the oscillator. I first noticed this when I was experiment with the oscillator operating on 14 MHz They're a number of sources that would case the frequency to change as a function of temperature.

1. The Varicap. As the temperature goes up the capacitance increases causing the frequency to go lower
2. The MPF102 likewise does the same thing when heated
3. The polystyrene capacitors reduce capacitance when heated
4. Silver Micas can go either way
5. The toroid didn't change very much with temperature T50-6

In my test circuit, I used polystyrene capacitors as the major frequency determining device. The Varicap used was either a MV2115 or a NTE618. All tests were made with the Varicap at full capacitance giving worst case condition.

Initially, if I found the frequency went down when the temperature went down the tap was too high. If they go the opposite direction, the tap is too low. (Normally the tap is set at about 1/3 the total number of turns on the coil.) On the 80 meter circuit, I reduced the change to essentially zero. The change as a function of the tap position is more noticeable as you go up in frequency to the 40 and 20 meter bands. I am not quite sure what is happening but I have a theory that it might be the result of heating the poly capacitor because of increased RF currents flowing in it as the coil tap is raised. The literature on oscillators say to use the lowest tap that produces oscillation for improved stability. In this case, improved stability is found by increasing the tap position. The net result is to cancel the other sources of drift due to temperature.

Since I didn't have a temperature controlled oven for the experiment, I took a reading before I went to bed and then opened the window of the radio room. (I can't call it a radio shack since it is a bedroom once used by one of my sons.) I usually observed at least a ten degree change the next morning. A home brew frequency counter was used for reading the changes. If you have a commercial receiver with counter, it could be used.

In the case of the Colpitts and Clapp, I didn't find this kind of change as a result of increasing C3 to increase the feedback coupling although this capacitor is already com-

pensating for temperature drift. In my circuit in the Deluxe QRP Station, QRPp journal Vol II #2, June 1993 I used a Clapp circuit that has a temperature drift of about 75 Hz per Degree F. I used polystyrene capacitors, 470 pF for C3 and C4 and 270 pF for C1 and C2. The Varicap was a MV2115.

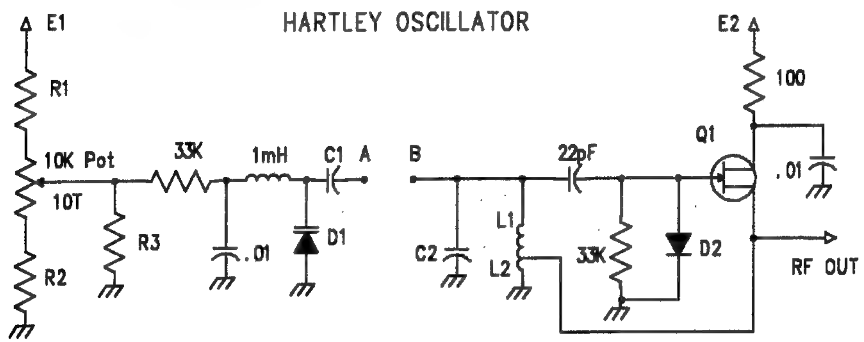
At 14 MHz I was satisfied with approximately 100 Hz/F using an NTE618 giving a tuning range of 2 MHz. With further adjustments, I believe I can reduce this even further. The circuit I am going to use this oscillator in will divide it by 2 thus reducing the drift even more.

Conclusion

Perhaps this discovery will lead others to try out this method of compensation. In the past I have tried other methods but never with good results. The Hartley appears to be the best circuit for this to work and, in addition, it uses the least number of components. You could be lucky with silver micas. Place a soldering iron next to the capacitor and see if the frequency goes up. If does, it could give similar compensation.

I wish to thank John Dorsey for perusing my article for errors or additions. John Dorsey's son is an amateur.

Note: In using Calculations, use the closest RETMA value for C1.



$$F = \frac{1}{6.28\sqrt{(L1+L2+2M)C2}} = L_t$$

$$M = K\sqrt{L1 \times L2}$$

$$\text{OR: } L1 + L2 + 2M + \frac{1}{39.4(F \times F)C2} = L_t$$

Where F is the upper frequency desired. Choose a value for C2 and solve for L_t.
NEXT: Choose the lower Frequency desired F and solve for a new C2.

$$C2_L = \frac{1}{39.4(F \times F)L_t}$$

THEN: $C2_L - C2 = CA$. If A is connected to B, then C2 is in parallel with the series combination of C1 and the Varicap capacitance of D1. The capacitance at A = $\frac{C1Cd1}{C1 + Cd1} = CA$

NOTE: CA must be less than the maximum capacitance of the Varicap in order that the solution be valid. Choose the maximum value for Cd1 (see text) and solve for C1. Then,

$L(\text{Coil}) = L_t - 2M$ Where 2M typically equals about $.1L_t$.

EXAMPLE:
Desired Frequency Range 7.0 - 7.3 MHz.
C2 = 270pF   Cd1 = 10 to 80pF
Solve for Lt for 7.3MHz

$$Lt = \frac{1}{39.4(7.3 \times 7.3)270} = L1 + L2 + 2M = 1.6uH$$

Solve for C2 to give 7.0MHz: $C2_L = \frac{1}{39.4(7.0 \times 7.0)1.6 \times 10^6} = 324\ pF$

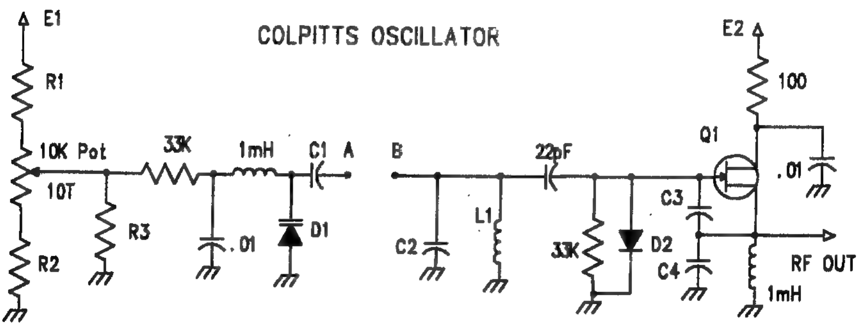
THEN: $C2_L - C2 = CA = 324 - 270 = 54pF$

Solve for C1: $CA = \frac{C1 \times Cd1}{C1 + Cd1} = \frac{C1 \times 80}{C1 + 80} = 54$

$C1(80 - 54) = 80 \times 54$

$C1 = 167pF$

and Lcoil + Lt - 2M where 2M = .1Lt   Lcoil = 1.6 -.16 = 1.44uH



If C3 = C4 and C5 = .5C3

$$F = \frac{1}{6.28\sqrt{(C2 + .25C3)L1}} \quad \text{or } L1 = \frac{1}{39.4F \times F(C2 + .25C3)}$$

Choose a value for C2 and C3 (see text) and solve for L1 where F equals the upper frequency desired.
NEXT: Solve for $C2_L$ where F_L is the lower frequency desired.

$$C2_L = \frac{1}{39.4 \times F \times F \times L1} - .25C3$$

Let $CA = C2_L - C2$ If A is connected to B, then C2 is in parallel with the series combination of C1 and the Varicap capacitance of D1. The capacitance at

$A = \frac{C1Cd1}{C1 + Cd1}$ or $C1 = \frac{CACd1}{CA + Cd1}$

Note: CA must be less than the maximum capacitance of the Varicap in order that the solution be valid. Choose the maximum value of Cd1 (see text) and solve for C1.
Example: Desired Range 7.0 to 7.3MHz.
C2 = 270 + 40 = 310, C3 = C4 = 470, C5 = .25C3 = .25 x 470 = 117 Cd1 = 40 to 400
Solve for L at 7.3MHz:

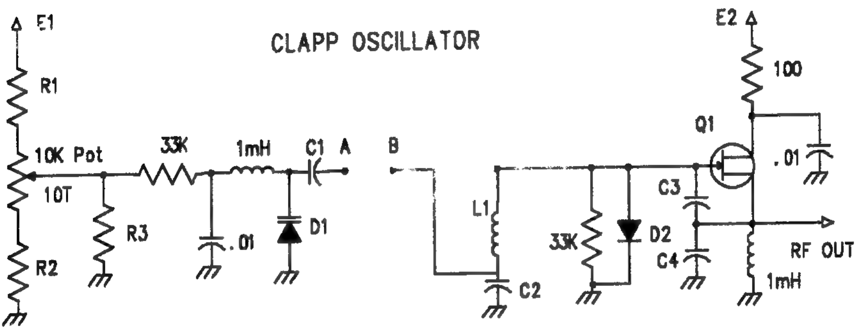
$$L = \frac{1}{39.4 \times 7.3 \times 7.3 \times (295 + 235)} = 0.8\text{uH}$$

Solve for C2 at 7.0MHz:

$$C2_L = \frac{1}{39.4 \times 7.0 \times 7.0 \times 0.8 \times 106} - 0.25 \times 470 \times 10^{-12}.$$

$$= 647 \times 10^{-12} - 117 \times 10^{-12} = 529\text{pF}$$

$$CA = 529 - 270 = 259\text{pF} \qquad C1 = \frac{CA \times Cd1}{Cd1 - CA} = \frac{259 \times 400}{400 - 259} = 735\text{pF}$$



$$\text{If } C3 = C4,\ F = \frac{1}{6.28\sqrt{\frac{Lt(FxF)C2C3}{2C2 + C3}}} \text{ OR } \frac{1}{\frac{39.4(FxF)C2C3}{2C2 + C3}} = \frac{2C2 + C3.}{39.4(FxF)C2C3}$$

Choose a value for C2 and C3 (see text) and solve for L where F equals the upper frequency desired.
NEXT: Solve $C2_L$ where F_L is the lower frequency desired.

$$C2_L = \frac{C3}{(39.4LxFxFxC3) - 2}.$$

Let $C2_L$ - C2 = CA
If A is connected to B, then C2 is in parallel with the series combination of "C1 and the Varicap capacitance of D1. The capacitance at

$$A = \frac{C1Cd1}{C1 + Cd1} \quad \text{or} \quad C1 = \frac{CACd1}{CA + Cd1}$$

Choose the hightest capacitance of Cd1 (see text) and solve for C1

Example: Desired range 7.0 to 7.3MHz.

$C2 = 270pF \quad C3 = C4 = 470pF \quad Cd1 = 10 \text{ to } 80pF$

Solve for L for 7.3MHz

$$L = \frac{2 \times 270 \times 10^{-12} + 470 \times 10^{-12}}{(39.4 \times 270 \times 10^{-12})(470 \times 10^{-12})(7.3 \times 7.3 \times 10^{+12})} = \frac{1010 \times 10^{-12}}{266.4 \times 10^{-7}} = 3.79 \times 10^{-6} \text{ or } 3.79\ uH$$

$$C2_L = \frac{470 \times 10^{-12}}{(39.4 \times 3.79 \times 10^{-6})(7.0 \times 7.0 \times 10^{+12})(470 \times 10^{-12}) - 2} = \frac{470}{3.44 - 2} = 326pF$$

Then: $CA = 326 - 270 = 56pF$

Solve for C1:

$$CA = \frac{C1 \times Cd1}{C1 + Cd1} \qquad 56 = \frac{C1 \times 80}{C1 + 80} \qquad \text{Or: } C1980 - 56 = 80 \times 56 \quad C1 = 196pF$$

An Integrated Keyer and Displayless Frequency Counter for QRP Transceiver

By Wayne Burdick, N6KR
1432 6th Ave.
Belmont, CA 94002
wayne@interval.com

I put a 10-turn pot into my NorCal 40A to increase the VFO tuning resolution, then realized that I'd need a frequency counter. Since I also wanted an internal keyer with a message buffer, I decided to follow through with a project I'd been threatening to do for a whole year: a microprocessor-based keyer and frequency counter.

In order to keep the size, cost, and current drain down, I gave up trying to use a display of any kind. Instead, the counter reports your operating frequecy using Morse code. The frequency report is sent as audio, directly to the A.F. amplifier, so the rig need not be keyed. This works very well for occasionally checking your operating frequency down to the nearest kHz. One side benefit is that you can easily read the frequency in the dark or while operating mobile. (Or both!)

History

The first time this displayless-counter idea struck me was when Doug Hendricks and I were driving to the Zuni-loop field day site in 1994. Doug thought it was a great idea, and I swore him to secrecy, which he honored. I didn't find time to work on it until just before Field Day 1995; I got it working just an hour before leaving for the Zuni-loop again. Fred Turpin, K6MDG, really put it to the test at FD.

Philosophy

I didn't intend this unit to be a replacement for the do-everything home-station keyer. In fact, you can still plug in a keyer or manual key into the existing key jack on the rig. What I wanted was an internal QRP keyer/counter module for field operation, where you don't necessarily need the big contest keyer with a dozen buttons that outweighs the QRP transceiver itself.

Description

The keyer/counter unit is based on a PIC 16C84 microprocessor. All parts and controls are mounted on a PCB that's only 0.8" tall and 2.5" wide, so it will fit on the front or rear panel of the NorCal 40 or 40A, Sierra, 40-40, or just about any other rig.

Because of the small size, there are only three controls: a speed pot, a message play/record button, and a frequency read/search button. A short press of the message button

plays a stored CW message; a long press records a new message. A short press of the frequency button reports your current frequency, while a long press enters a search mode, in which you use the keyer paddle to send the unit a frequency to search for. Pressing both buttons at once puts you into command mode. (Given my recent rants about ergonomics, I won't tell you all the complicated things you can do in this mode!)

Keyer Details

The keyer is Iambic, with user-programmable keying behaviour. There's quite a debate about which Iambic mode is best, so I included variations of both A and B. The non-volatile message buffer holds up to 48 characters, and messages are sent with automatic character and word spacing. There are several fixed keying weights selectable in command mode, as well as optional side-tone. Finally, there is a TUNE command for doing antenna tuner and transmitter tune-up.

Counter Details

The counter function is performed with the help of an inexpensive 74HCT4020 divider IC. This IC divides the VFO frequency by 256. The PIC counts the output of the divider for 256ms, then adds or subtracts this from a programmable offset. The VFO can be up to 8MHz, and by setting the offset to 0, the unit can even work with direct conversion rigs.

In the case of the NC40 or 40A, the VFO runs at 2085 kHz when the operating frequency is 7000 kHz. To get the proper 3-digit frequency reading, the offset is programmed as "A915," or "add 915 to the VFO." So if the PIC counts the VFO as 085 kHz, it adds 915, which ends up as a report of "000."

The keyer/counter unit can store up to four VFO offsets, so you can use it with multiband rigs that have up to four different band edges. For example, with the Sierra, you could use the "M0" and "M1" jumpers on the band module as inputs to the keyer/counter. When you plug in the 80-meter module, it would select an offset corresponding to a band edge of "500" instead of "000".

In search mode, you use the keyer paddle to send a 3-digit frequency to the counter, then turn the VFO knob until you hear it send a special "frequency found" tone.

Noise? (Not!)

Microprocessors put out a lot of noise which can trash your receiver. I used two techniques to prevent this with my keyer/counter. First, as long as you're not hitting a button or keyer paddle, the PIC is asleep with its oscillator turned off and the divider I.C. is held in reset. Second, the receiver is kept muted as long as the processor is awake. Result: no buzzes or carriers anywhere—regardless of what I.F. or operating frequency is in use.

Summary

As of this writing, the schematic and firmware for the keyer/counter module is still in a state of flux, but I have built and field-tested a prototype. By the time you read this, Wilderness Radio will have them in stock as the "WRA-1"—Wilderness Radio's first QRP accessory kit. (Call Wilderness at 415-494-3806 if you're interested, or write to P.O. Box 734, Los Altos, CA 94023-0734. In addition to a complete kit, Bob will be selling the programmed microcessor by itself. In this case, you'll need to add your own speed pot, switches, and a small number of other parts.)

Now I can turn my attention to the last frontier for the NC40A: an internal automatic antenna tuner....72, Wayne, N6KR

3806, or write to: P.O. Box 734, Los Altos, CA 94023-0734

For Sale: NorCal 40A kit, never opened, $110 Cash. Hollis Button, 1025 W. Parr Ave., Campbell, CA 95008. Phone: 408-378-0436.

A Better Mouse Trap

By Ernie Helton, W8MVN
36 Walnut St.
Franklin, OH 45005

After erecting a 70 foot tower about ten years ago I tried a variety of different types of 40 meter antennas all of which were supported by the tower. Included were dipoles, inverted vees, slopers (both quarter wave and half wave versions), G5RV, bazookas, windoms and extended zepps. Not necessarily in the above order, all of the antennas worked to some extent. No attempt will be made to rate one type vs. another in the following information.

Problems arose using some of the above antennas when they were supported by my tower and its associated guying. My definition of problems include; difficulty resonating the antenna at the desired frequency, unable to get a good impedance match to the feedline, drastic changes in VSWR when the 4 element 20 meter mono bander was rotated, and lots of RF on the rotor control cable at operating position. The worst problems occurred with inverted vees and slopers.

Roy Lewallyn, W6EL with Ernie, W8MVN and his model of his Antenna System

Ok, "What if" I replace the guy wires with a non-metallic material. Phillystran was chosen to replace the metal guys. This resulted in some improvement but apparently the

tower itself was causing most of the problems. The tower alone approximates a 1/2 wavelength vertical at 40 meters. Since most of the antennas mentioned earlier are high Q types and all were adversely affected by the presence of surrounding objects like the tower and its guying. How about a loop???? They are low Q compared to the others. What if I replace the upper guy with a Delta loop configuration? My guying system consisted of four guys at the upper and lower levels and a 12 foot yard arm was used at the upper level to support the wire antennas. A single loop was fabricated and resonated at the desired frequency and matched to the 50 ohm feed line with a quarter wave length of 75 ohm coax. This single loop was used for an extended period with excellent results and none of the problems noted earlier with the other types. It worked so well in fact that I decided to add a second identical loop on the opposite side of the tower to replace the other guy at the upper level. See Figure 1 for details.

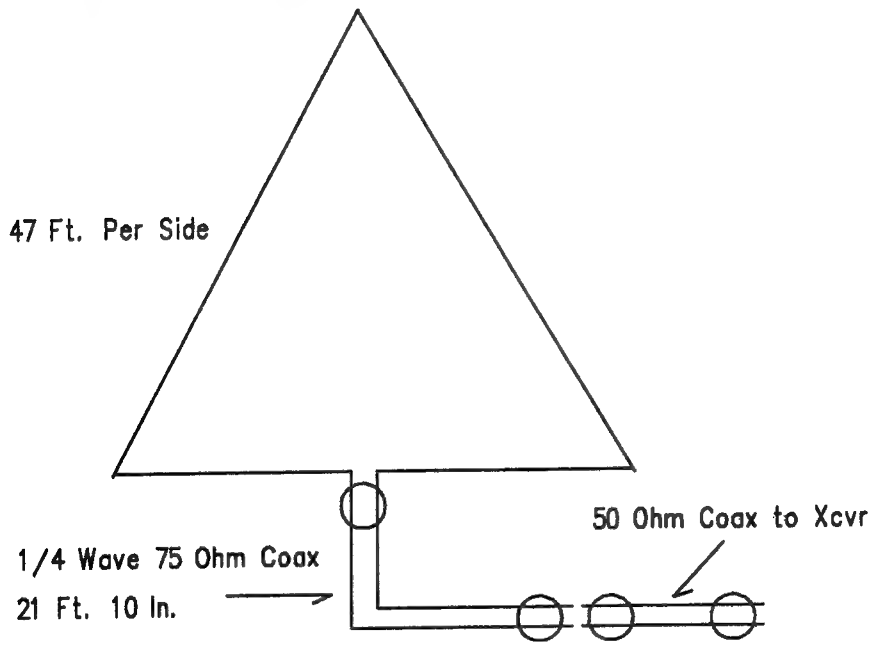


Figure 1

The second loop was built using the same techniques as the first one. The lengths shown are starting points and the loops are to be trimmed to resonance and the 1/4 wave matching sections are trimmed for best impedance match with the loops in position. Now the real fun begins. How do we match the two loops which are 50 ohms impedance to the transceiver? The two loops in parallel now look like 25 ohms to the transceiver. for impedance transformation I used an UN-UN per Dr. Jerry Sevick's book. The details for winding the line transformer are included in Figure 2.

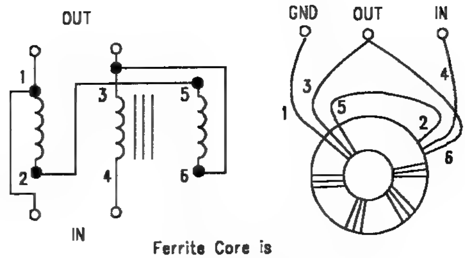


Figure 2

The transformer may be checked for correct connections by using two 50 ohm loads connected to the output side. I tested with a 50 ohm load and a 50 ohm terminated load wattmeter which now indicated approximately 2 watts. Half the 4 watt output from my Ark-40 transceiver was being dissipated in the 50 ohm dummy load and the remaining half or 2 watts was being dissipated in the wattmeters internal load. It is very important at this point that the loops are identical electrically.

This two loop configuration was used for several months and several QRP contests. Some very interesting comments were received from other stations.

"You can't be QRP. Your signal is over S9."

"Your signal was the loudest QRP signal I heard during the entire contest."

It sure would be nice if we could control the directivity of the two loops. Figure 3 shows the two loop configuration used.

This configuration was used about a year and a half with very gratifying results. then the thought arose why not try to control the directivity by feeding one loop and using the other as a reflector similar to a 2 element quad. At this point the two loops were identical electrically with the same resonant frequency and the same feed impedances. What was needed now was a method to lower the resonant frequency of the reflector element. After researching I found I could lower the resonant frequency of the reflector element by adding an open circuit stub of coax.

Most design information for Quad antennas indicate the reflector should be 5% longer than the driven. A stub length of .44 wavelength appears to be about right. Since both of the loops are using the same 1/4 wavelength matching sections of 75 ohm line it was now necessary to trim the 50 ohm feed line to the correct length. I started with a length of 40 feet including the 75 ohm section. The lengths are based on velocity factors of .66 for the coax used.

The next thing was to be able to switch the driven and reflector loops to change directions. Note: **When switching coax feeds, both sides must have the shield on the coax isolated from ground.** Grounds are provided by relay contacts as required. A diagram of the relay switching is shown in Figure 5. The box containing the relays was then placed in the "dog house" already in place on my tower.

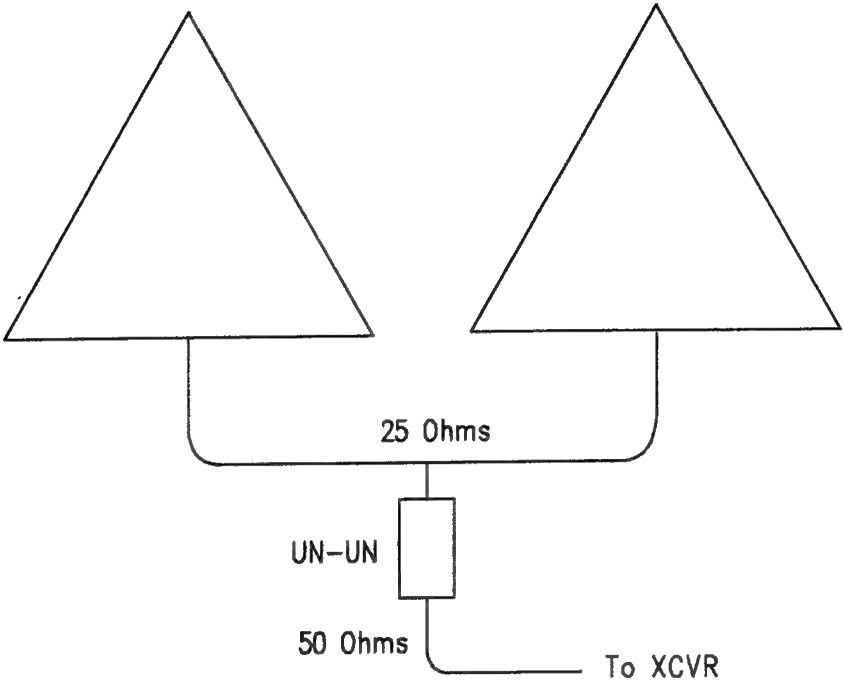


Figure 3

Relay Switching Functions

Antenna Direction	Relay 1	Relay 2	Relay 3	Relay 4
Loop 1 (East) OFF	OFF	OFF	OFF	
Loop 2 (West) ON	ON	OFF	OFF	
Both Driven	ON	ON	ON	

Relays are all DPDT type readily available in most flea markets and DC relays are recommended. Low power types are OK for QRP operation.

Summary:

During the course of many QRP QSO's I have been asked "Exactly what type of antenna are you using there?" I find it is very difficult to describe this antenna system with any degree of clarity. Most of the time I describe it as part of the guying system on my tower and the loops are sloping about 45 degrees. You might even go as far as calling it a two element Delta Beam with a 1/2 wavelength vertical stuck in between (the 70 foot tower being the vertical.)

This antenna system evolved over a period of several years but started with a single delta loop and progressed from there. The purpose of this article is to encourage others to do some experimenting with antennas. No elaborate lab type equipment is required to accomplish the end results. Minimum equipment being a MFJ VSWR analyzer. I

startedwith a Model 250 but have since replaced it with a newer version Model 259 which has proven to be quite adequate for my antenna experimentation.

Your comments and suggestions are welcomed, but a self addressed stamped envelope will be much appreciated. 72, Ernie

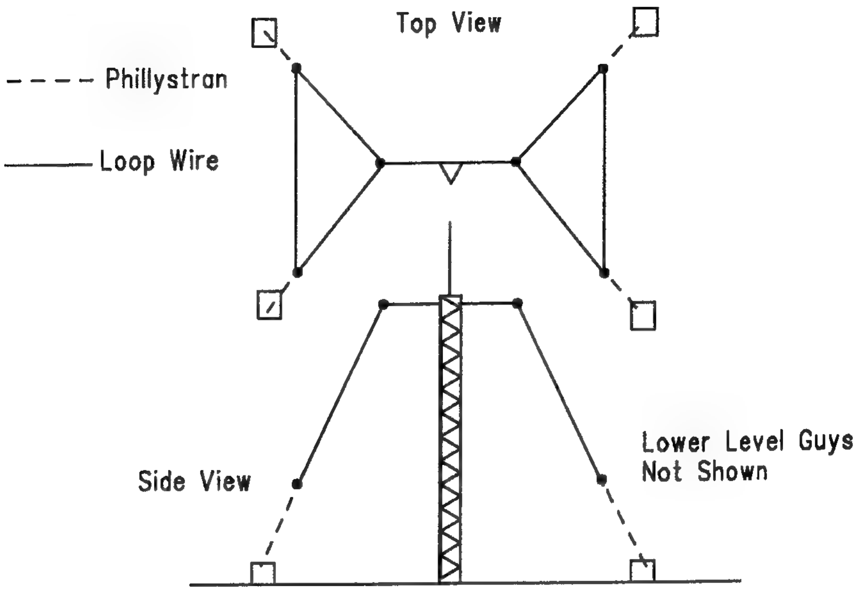
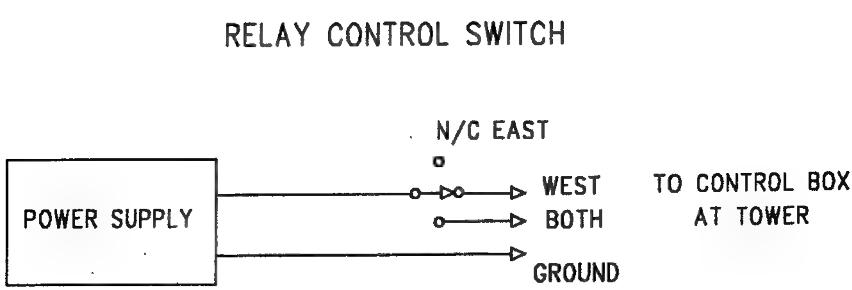
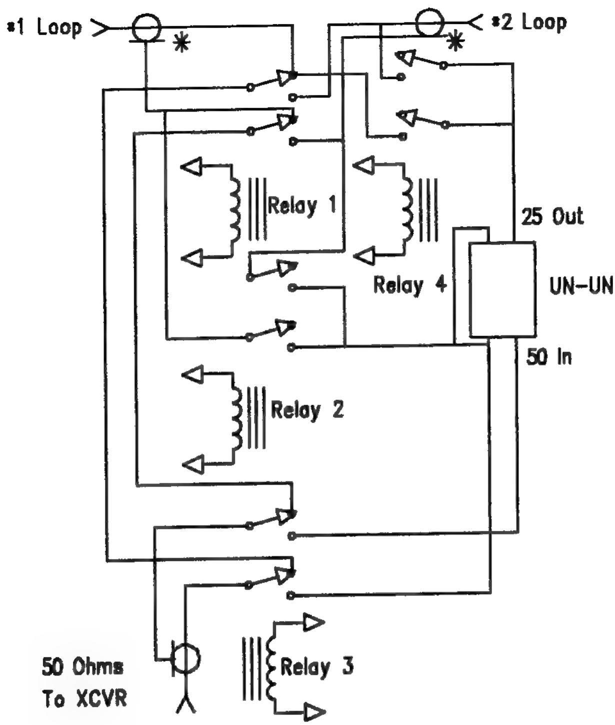


Figure 4





*These fittings must be isolated from common ground. Ground connections are controlled by relays.

Figure 5

A Field CW Key from a Keyboard Key Switch

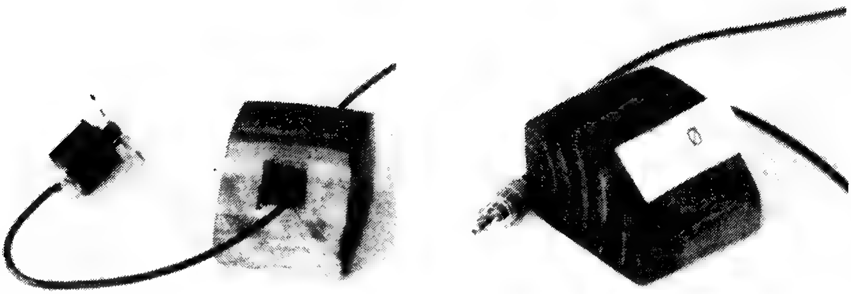
By L. B. Cebik, W4RNL
1434 High Mesa Drive
Knoxville, TN 37938
e-mail: cebik@utkvx.utk.edu

Small keys for field and mobile use are hard to come by, although a few magnificent and expensive works of art do exist, along with some cheap plastic and spring models. However, most QRPers can make a good field key, and probably at no cost. Well, maybe a buck or two for supplies.

A CW straight key is just a switch: technically, a normally-open momentary-contact

single pole single throw switch. The J-38, perhaps the legendary standard of war surplus fame, was made to handle cathode current. Modern rigs use 4-6 volts at well under 1 mA, so the beefy metal work is no longer required. any good switch that fits the fingers that do the sending, that has a reasonable stroke length and return spring, and that can endure manyoperations will do as a CW key. If it happens to be small, so much the better.

Older computer and terminal keyboards, even nonfunctional ones, have 75 to 100 poetential CW keys on every board. The double-wide key caps will satisfy everyone except those committed to Navy knobs. The key switches are durable, but with the right construction, replacing the one in use with a spare is a 30 minute job. I have some 1.25"



long key switches from a very, very old keyboard, but the next generation of key switchees are about 0.75" long with 0.125" long contacts and a case about 0.563" (9/16") on a side. This is perfect for a field key.

The pictures shows the detail of how I encased one in wood. I shaved the 45 degree face in a 2x4 with a table saw, then cut the 4" dimension to 2" and finally took a 1.75" block. The last dimension ensures that the double wide key cap fits within the width of the block.

To make the cut-out for the key switch, I used a drill press to cut the perimeter a wee bit smaller than the case. A Dremel Moto-Tool finished the cut out for a tight press fit of the key switch case. The extra hollow is for the terminals, and the 1/8 inch hole is for the RG-174 cable to the rig. A little sanding, staining, and finishing dresses the key base proudly.

Run the RG-174 through the hole to the cut out. Solder the conductor and shield to the unmounted key switch terminals, and press the case into the cutout wile drawing the cable back out. Do not drill the cable hole too large, since it acts as a strain relief fitting. Glue a pad to the bottom. (I used a piece of textured rubber from a jar cap opener pad.) Then start practicing.

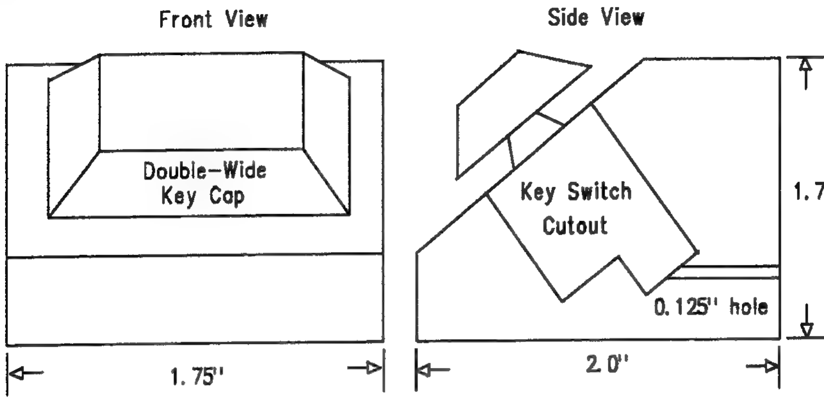
Why the 45 degree face for the key? Two reasons. First, with the key switch vertical, it is too high for easy keying at a desk. In addition, the angled fit, with the contacts oriented up, makes a good fit for accessigble scrap wood.

Second, the 45 degree angle permits keying at almost any angle from 30 to 90 degrees relative to the table top. Many bangers curl (or cramp) their fingers for vertical strokes. The construction of the key switch easily translates this motion into good contact. A more relaxed finger position is closer to the angle presented by the key cap, and with practice, the strain of straight key CW goes away. With the no-slip pad on the bottom, gentle

keying does not make the key walk away.

I anticipate about a year's service from each key switch and have a life time of spares (but no more, since my key switches were left over from a CW keyboard project several years ago.) A full keyboard might serve a club for a decade, even throwing out the unreliable ones. The wood block should last forever. The limiting factor is finding the double wide keycap with a center mounting slot. Soume double wides only have offset mounting slots. "Zero" from the numeric keypad is a good choice and mystifies casual onlookers.

This little key is open to unlimited variations of building style to suit the skills and operating styles of the maker. It is the best "no cost" key I have found.



Some Ideas For an All Band Rig

By Raymond Megirian, K4DHC
606 SE 6th Ave.
Deerfield Beach, FL 33441

During the past dozen years I have done a lot of experimenting with circuitry for an all-band CW/SSB QRP transceiver and have come up with several working models. Mostly they became victims of a relentless desire to see if things couldn't be improved or simplified and were torn apart. The latest one, however, was put on the air by a good friend (I'm a builder not an operator) and has provided excellent results. The rig uses a synthesizer to generate all the LO frequencies and also has a built-in frequency readout. A very compact version of the huff and puff drift correcting circuit was also designed for the VFO and will be described along with the other two sections.

Keep in mind a few of the design features incorporated in the all-band rig. A 2-pole, 12 position rotary switch does all the band switching. One section supplies 12 volts to all switched circuitry except the synthesizer and circuits requiring a regulated voltage. Regulated 10 volts is supplied to these sections via the second switch wafer. The IF is 9MHz and the VFO tunes from 5.5 to 5.0 MHz.

Synthesizer

A Motorola MC145106 PLL IC is used to synthesize all the LO injection frequencies for 12 bands. These include 160, 80, 40, 30, 20, 17, 15 and 12 meters as well as 4 500-kHz segments for 28 to 30 MHz. A 10.240 MHz crystal and on-chip oscillator generate

Ray Magerian's All Band CW/SSB Transceiver

the reference frequency of 10 kHz. Four VCOs are used to cover the required spectrum of 16 to 44 MHz. Diodes are used to program the internal divide by N counter and are supplied with regulated 10 volts from the bandswitch. The output from the VCOs is fed to a broadband amplifier and then to a divide by 10 prescaler to bring the frequency within range of the PLL input. The signal from the amplifier is also fed to one input of a double balanced mixer. The other mixer input is fed from the VFO. The difference frequency is filtered out, amplified, and becomes the LO signal. Table I shows all relationships of these frequencyies and Table II shows the divide by N program.

The post mixer filter is a tuneable affair made up of RF chokes and tuning diodes. It will cover the entire range of 10.5 to 39.0 MHz. Twelve trim resistors mounted on one of the 2 PC boards are each preset to one band and selected by the band switch. The amplifier following the filter is gain controlled so as to provide as constant an output level as possible. The MC145106 provides an out-of-lock signal which is applied to one half of a dual comparator whose output lights a front panel LED to indicate system lock. The other half of the comparator provides an output to inhibit the transmitter in the rig if lock is lost. The 10-volt regulator IC is of the low dropout variety so as to maintain regulationwhen the supply falls below 12 volts. The output from this supply is used not only internally but is brought out to supply one section of the bandswitch and other portions of the rig not shown here.

As mentioned above, the sythesizer is assembled on 2 PC boards. Both boards measure 2 x 4 inches and are stacked sandwich fashion in order to make a compact package. The resulting assembly was housed in a box made from double-sided PC material with outside dimensions of 4-1/4 x 2-3/4 x 1-5/16 inches. All of the interconnections are brought to pads that line up one above the other, making the sandwich more appetizing. Snappable type header material was used for the connections between boards. Male type on one board and female on the other makes it possible to separate the boards if necessary. All electrical connections to the outside are by means of feethru capacitors. RCA phono jacks are used for RF inputs and outputs.

The boards were made using double-sided copper clad material. One side is used as a grond plane and is unetched. Parts are mounted on this side and any part with a lead going to ground has that lead soldered right to the copper surface. Obviously, copper around the through holes must be relieved to prevent shorts. Those holes not to be relieved are marked with an (*). Most of the diodes, chokes and resistors are mounted hairpin fashion but where the span is sufficient a component can lie flat. Before mounting

the MC145106, bend pin 5 straight up and cut off pin 6. Pin 5 becomes a test point and pin 6 is not used. There are no holes in the board for these pins. The 10.240 MHz crystal is a tiny cylindrical type which is mounted with its leads sufficiently long so as to allow the crystal to lie flat on top of the IC. I used a small piece of 2-sided tape to hold it in place. The 10 volt regulator is mounted flat on the ground plane with a screw and nut.

On the bottom board, pins 1,4 and 8 of U1 must be bent to lie flush on the ground plane since no holes are provided. The same goes for the grounded pins of D5, D6, D7 and D8. The tank coils for the VCOs are wound as follows: L1 has 26 turns tapped at 5 turns on a T30-2 toroid. L2 has 20 turns tapped at 4 turns on a T25-6 toroid. L4 has 13 turns tapped at 3 turns on a T25-6 toroid. All coils are wound with #30 wire. Taps are from ground end. Tuning diodes D1-D4 are Motorola MV1662 whcih come as a matched set of 3 but not all sets match each other. A sufficient number should be on hand so that a set of 4 matched diodes can be installed in the filter. Diodes having the same 3-color stripes on their backs would be matched units. Sources will be discussed later.

A high frequency scope and a counter are used to set up the synthesizer. The VCOs have to be adjusted for correct frequency range before the moards are mated. Temporarily tack a piece of wire to the common output line of the VCOs for connection of the scope and counter. Do the same for the common line feeding the tuning diodes so a variable supply of 0-9.5 volts can be applied. Since each VCO covers more than 1 band, 12 volts can be applied to any one of the inputs for a particular VCO and the output frequency checked for the required range. The schematic shows what bands each VCO covers and the frequencies determined from Table I. VCO #3, which is used for 20 and 17 meters, would have to cover from 28.5 to 32.6 MHz. Adjust for the proper range by squeezing or spreading the turns on the coil and when set properly, apply enough Q dope to hold the turns in place as well as to glue the coil to the board. When all VCOs are operating within their specified limits with the tuning voltage of 0-9.5 volts, remove the temporary test leads.

Before mating the 2 boards, solder leads to all the pads going to external connections, making them slightly longer than needed. The board containing the PLL is mounted on top. When assembly is complete, connect a 12 volt supply and VFO to the appropriate inputs. The VFO level should be around 1V P-P. Connect the cathode end of a LED to the LOCK feedthru and the anode to the 12 Volt supply. Apply power and if no smoke is observed, commence set up.

Connect a counter to the pin 5 test point on the PLL and adjust the trimmer capacitor for a frequency of 5.120 MHz. (The 10.240 MHz frequency has been divided by 2 at this point.) Next, connect a high frequency scope and the counter to the LO output and a clip lead from the 160 meter feedthru to the regulated 10V feedthru. It may be a little tricky but a small thin screwdriver can be used to adjust the associated trim resistor for an output of 10.5-11.0 MHz as the VFO is tuned through its range. The counter will verify that you are tuned to the desired mixer product and the scope display will allow adjustment of the filter for a clean signal throughout the segment. This procedure is repeated for each of the remaining bands. While operating on any band, adjust R4 till the LOCK LED just comes on and then a few degrees more. Check all bands to make sure the LED is working and extinguishes when no band is enabled. When the LOCK LED is off, the TRANSMIT INHIBIT output should go high.

The LO output is apporximately 1V P-P and sufficient to drive a DBM such as the SBL-1. The LO is capacitor coupled to the output jack. The second LO output is used for the digital readout and is not DC isolated since a coupling capacitor is located in the readout assembly. If the readout is not to be used, associatd parts may be omitted.

To prevent the bottom board form shorting out against the bottom of the box, a piece of insulating material was placed between board and box. Cut 4 pieces of heavy bus wire

to a length about 1/2 inch longer than the space between boards. Feed each of these pieces through the 4 corner holes till they are flush with the bottom and flow solder around the wire and ground plane of each board. The extra half inch can be bent to rest against the inside of the box and soldered in place. This provides a common ground for everything as well as holding the assembly in place.

Frequency Readout

The heart of the frequency readout is the Sub-Cub 1 by Red Lion Controls. This little device contains all of the counting circuitry and 6 digit LCD in a package approximately 1-1/16 x 11/16 x 7/16 inches. The unit is fastened to a small PC board by its own ramp-lock pins and fed by cable from the remaining circuitry which is housed in another small box made from PC material.

The LO signal from the synthesizer connects to one input of a NE602 mixer while the other input is from the carrier oscillator (BFO). When mixed, these signals produce a difference frequency equal to the operating frequency. This signal passes through a filter to separate it from the other mixer products and then is divided by 100 in order to come within frequency range of the Sub-Cub counter which will operate up to 500 kHz. The standard 1-second time base is generated by a 3.58 color burst crystal and MM5369EST IC. This produces a 100 Hz output which is divided by 100 in a RDD104 IC to end up as the 1-second clock. A CD4528 dual monostable oscillator generates the latch and reset pulses for the Sub-Cub 1.

A tuneable filter similar to the one used in the synthesizer is employed here to extract the operating frequency from the mixer. However, this filter will not cover the entire range from 1.8 to 30 MHz so it was used in conjunction with a fixed bandpass filter for 160 and 80 meters. The tuneable filter covers the remaining bands of 40 through 10 meters.

The original rig contained a small board which acted as a main junction point for all the bandswitching cables as well as a few miscellaneous components which included the preset trim resistors for the readout filter. Since these were not mounted on the main board and since the layout was not compatible with standard size components, no PC artwork is shown. The main object was to introduce the Sub-Cub 1 to those not familiar with it and suggest the possibilities of including it in a readout for your rig.

With a 1-second time base there will obviously be a lag in the frequency being displayed as the rig is tuned across the band. I used a supplemental dial for ordinary tuning and the counter to indicate the exact frequency when parked. If desired, a switch can be incorporated to connect pin 1 of the RDD104 to the 6-volt supply in which case the time base becomes .1 second and allows the counter to follow more rapidly. This will result in the loss of 1 digit, however, and resolution becomes the nearest 1 kHz rather than the nearest 100 Hz. The switch can be a push button used only to achieve fast count when desired and allow return to normal when released. The schematic shows this option.

As shown on the schematic, both bandswitch sections are used to control the readout. The regulated 10 Volt section is used to supply the trim resistors which tune the filter for 40 to 10 meters. The 12 Volt section is used to enable the particular filter in use. Connect a scope to the test point noted on the schematic and with the rig tuned to either 160 or 80 meters, adjust the 200K trimmer for a square wave output. The frequency reading should be correct for the band in use. Check both 160 and 80 meters for proper readings throughout the entire range. The remaining bands are individually tuned by their associated trim resistors. The 10 meter band requires only a single trimmer but make sure the counter works properly across the entire range of 29 to 30 MHz. The filter will tune to various mixer products which produce falsecounter readings so adjust the pots slowly till the Sub-Cub reads what you are looking for. Fine adjustment of the 200K threshold pot may also

help; especially on 10 meters where a very wide band is being covered.

The small single-sided PC board required for mounting the Sub-Cub 1 is shown along with the artwork for the other boards. The elastomeric conductors on the back of the device compress against the pads on the board which should be clean and smooth. The data sheet suggests gold or tin-lead plating. I used Cool-Amp silver plating powder on mine. The 2.4M, 1/8 watt resistor should be mounted on the back of the board so as to not interfere with the Sub-Cub 1. The 2 outermost holes are for mounting the board to the front panel. I made a rectangular hole in the front panel just large enough to view the display and allow the remaining frontal area of the Sub Cub to butt against the back of the panel. A pair of long 2-56 screws were then passed trough the front panel and the 2 mounting holes in the board to snug up the assembly and hold it in place. The inner holes accept the lock-ramp pins on the back of the Sub Cub 1 and are to be .120" in diameter. The polarizing pin goes in the hole above the left mounting hole and is .093" in diameter. The 4 leads feeding the display were fed though a piece of shield salvaged from scrap coax. The shield was grounded where it exited the readout box and connected at the other end to the ground return pad on the Sub-Cub board.

Drift Corrector

I have been using this marvelous device since the '70s and feel that PA0KSB should be awarded a medal for his achievement. There have been many follow-ups over the years to Klaus Spaargaren's gem and the only reason I included it here is to present a very compact version of the circuit using standard components. Size reduction for this unit was achieved through the elimination of one 16-pin IC and substitution of an 8-pin IC for a 16-pin one. The customary crystal was also changed to a tiny 100 kHz unit which made all the above changes possible. This brought the size of the board down to 1-1/2 x 1/1/2 inches.

I'll not go through any theory here but if you are interested you can refer to articles in Ham Radio for December 1977 (PA0KSB), June 1979 and August 1987. There have been others but these should suffice.

Some indication as to the status of the DC control voltage being applied to the tuning diode is necessary in order to keep the voltage within operating limits or control will be lost. PA0KSB used a small meter across the control line to monitor the DC level and I favor this method myself. Some of the articles mentioned above used LEDs to indicate when the voltage was near maximum or minimum but the added circuitry and IC's would have defeated my desire to keep it small. The meter used is one of the once popular 1/2" round status indicators used on battery operated devices. There are some of these still around and can be found at hamfest flea markets. A 500 uA movement is common and quite suitable. A series resistor is selected to allow full scale deflection with maximum control voltage. The UP and DOWN push buttons are used to bring the control voltage within operating limits and also useful for fine tuning the VFO when the other station drifts. My VFO stays on frequency for hours right from turn on.

A double sided board was used here too, with the unetched side used as a ground plane. Here again the copper around through holes must be relieved.

The most troublesome component used in the device is the 100 meg resistor required for the long time constant. Generally a bunc of resistors in series is the accepted means of satisfying this requirement but I have shown only 2 holes in the PC board. At one time I actually ahad some 100 meg, 1/8 watt resistors given to me by my friend NI4Q (who now has the rig) so I know they actually made such things. However, I have never seen or heard of any others and don't know where he got those many years ago. Instead, I make my own form carbon composition types. I have a bunch of 1/8 watt, 22 meg resistors that have been in a drawer for years and now have a noble purpose in life. By heating these wtih a

soldering iron I can get them to assume much higher values of resistance. I built a megohmmeter to monitor the resistor while heating it so that I could zero in on 100 megs. Several applications of the iron are necessary to get the part to settle at 100 megs as it cools. One can also go too far and end up beyond 100 megs so spares are needed. After a couple of weeks I check them again to make sure they are fixed at somewhere between 90 and 100 megs.

If you are planning to build this item you can bundle a series string of 1/8 watt resistors and insert the start lead in one hole and the tail lead in the other hole or re-do the artwork with more holes and make a new board. Also, as long as my supply lasts, I will send you a manufactured resistor for a SASE.

Almost any varactor diode of small capacitance can be used to control the VFO. I used a 4000 series glass rectifier diode with good results. The amount of coupling capacity to the VFO tank coil will vary with design of the circuit but generally will be only a few pFs. Check the total frequency excursion around mid-band by using the UP/DOWN push buttons. About 3 kHz is desirable and if necessary, the value of coupling to the tak coil can be adjusted.

Before installing U1, bend pins 1, 2, 3, and 4 to be flush with the ground plane. Do the same with pins 4, 6, 7 and 8 of U2 and also cut off pins 2 and 12. U3 has pins 4, 6, 7, 9, 11 and 13 cut off and pin 10 grounded. Cut off pins 1, 5, and 8 of U4 and ground pin 4. The 20 meg resistor across pins 5 and 6 of U1 was made up of 2 10 meg units since at the time I had no 20 meg resistors and was not manufacturing custom parts.

Concluding Comments

When I first asked Doug Hendricks about the suitability of doing this article, he thought I should cover the entire rig. This would have been much too cumbersome for the limited interest it might create and would not have been easily duplicated. Instead, I chose to present a few ideas that worked well for me and could perhaps give other readers ideas to put to use in their own designs.

Digikey Corporation was the source for some of the parts used in these projects:

Low profile TV crystal	X079-ND	$1.56
10.240 MHz crystal	SE3421-ND	$1.29
100 kHz crystal	SE3333-ND	$1.44
6 mm trim resistors	Various	$0.51
1.0 uF film cap[	P4675-ND	$0.75
Sub-Cub 1	RLC1000-ND	$18.00

The matched sets of 3 tuning diodes are available from: Marlin P. Jones & Assoc., Inc. P.O> Box 12685, Lake Park, FL 33403 for $1 per set. Same price also from: Hosfelt Electronics, Inc., 2700 Sunset Blvd., Steubenville, OH 43952.

The BB104 dual tuning diodes were purchased from: Fertik's Electronics, 5400 Ella Street, Philadelphia, PA 19120. Price and availability at this time unknown. The electrolytic capacitors were tantalum while the coupling and bypass capacitors were mostly monlythic types. Resistors were 1/8 watt carbon film and as many parts as possible were of the miniature variety.

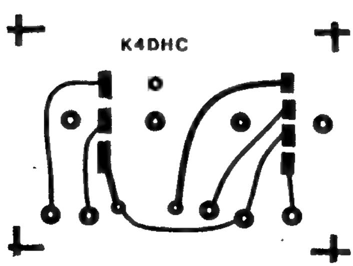
If I ever get the next rig finished, I may get on the air again after over 40 years of inactivity. 72, Ray, K4DHC

TABLE I

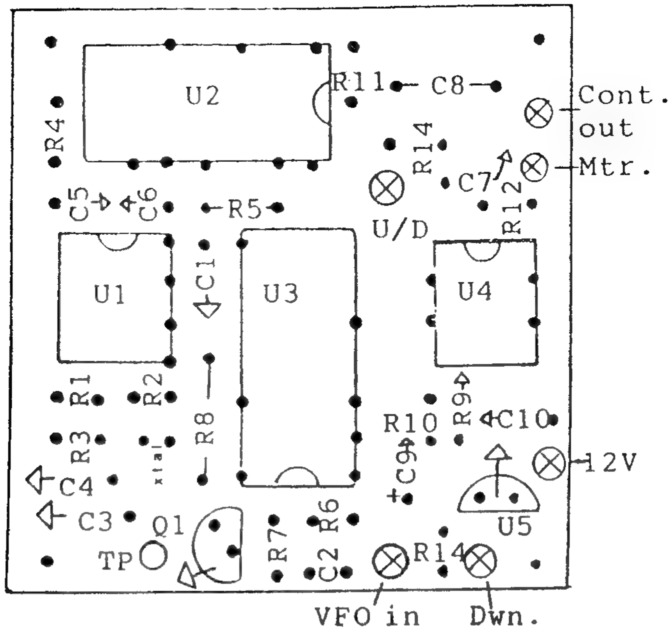
Band	Syn. Out (MHz)	LO Injection (MHz)	Band Coverage
160	16.0	10.5-11.0	1.5-2.0
80	18.0	12.5-13.0	3.5-4.0
40	21.5	16.0-16.5	7.0-7.5
30	24.5	19.0-19.5	10.0-10.5
20	28.5	23.0-23.5	14.0-14.5
17	32.5	27.0-27.5	18.0-18.5
15	35.5	30.0-30.5	21.0-21.5
12	39.0	33.5-34.0	24.5-25.0
10	42.5	37.0-37.5	28.0-28.5
10	43.0	37.5-38.0	28.5-29.0
10	43.5	38.0-38.5	29.0-29.5
10	44.0	38.5-39.0	29.5-30.0

TABLE II

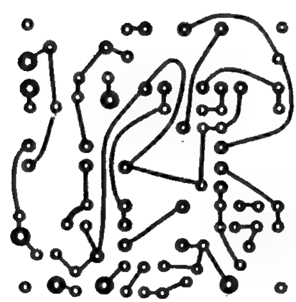
Syn. Out (MHz)	Div. by	Program Powers of 2
16.0	160	7+5
18.0	180	7+5+4+2
21.5	215	7+6+4+2+1+0
24.5	245	7+6+5+4+2+0
28.5	285	8+4+3+2+0
32.5	325	8+6+2+0
35.5	355	8+6+5+1+0
39.0	390	8+7+2+1
42.5	425	8+7+5+3+0
43.0	430	8+7+5+3+2+1
43.5	435	8+7+5+4+1+0
44.0	440	8+7+5+4+3



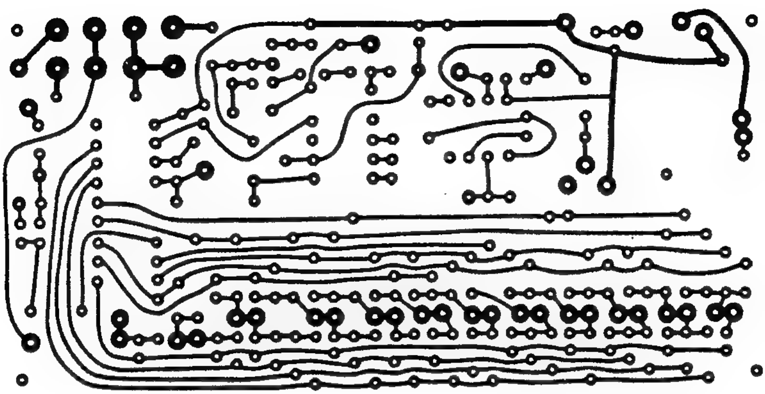
Sub Cub Mount (Copper Side)



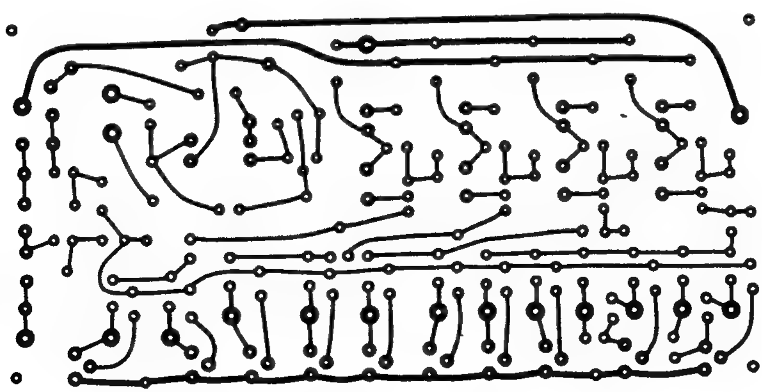
Drift Corrector Parts Placement



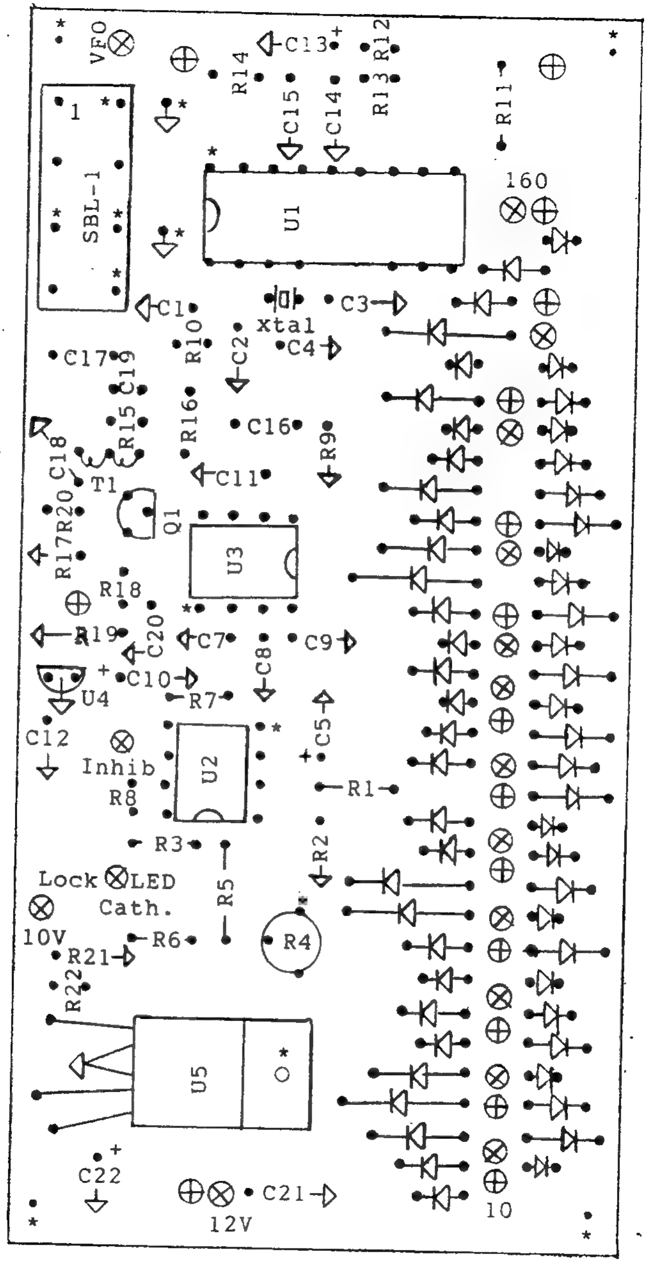
Drift Corrector (Copper side)



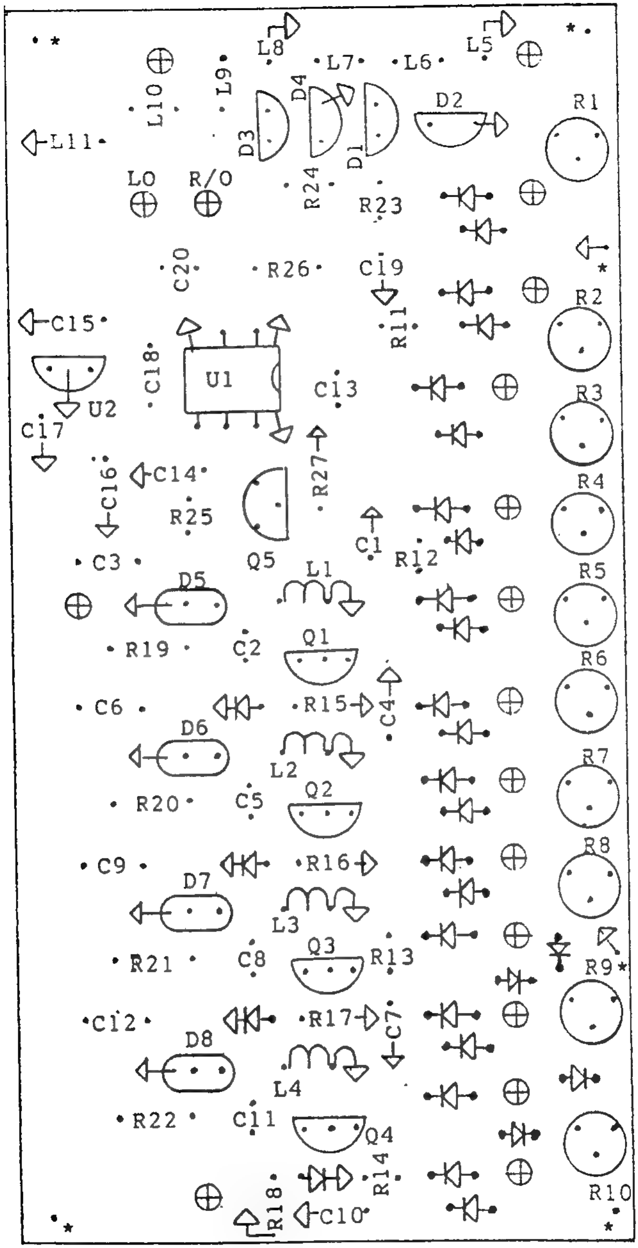
Synthesizer Top (Copper Side)



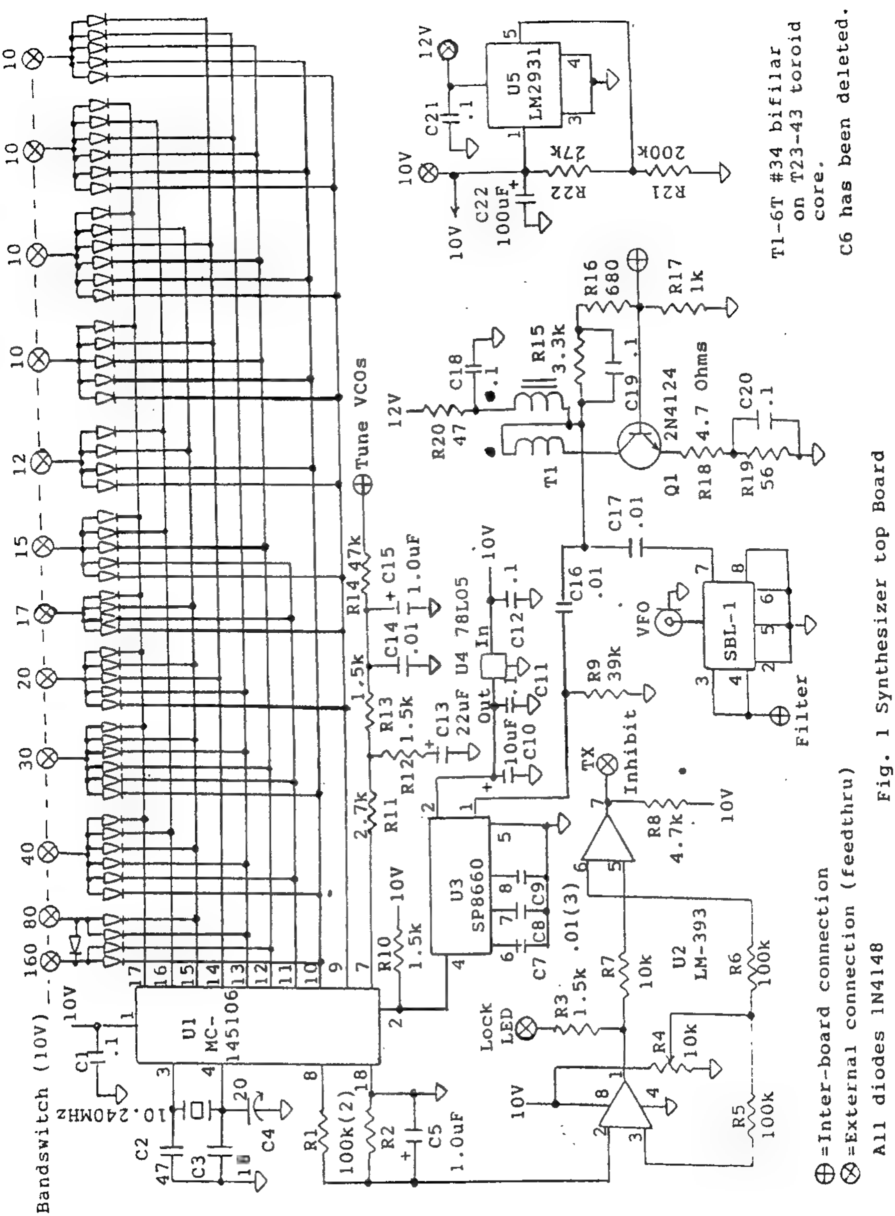
Synthesizer Bottom (Copper Side)



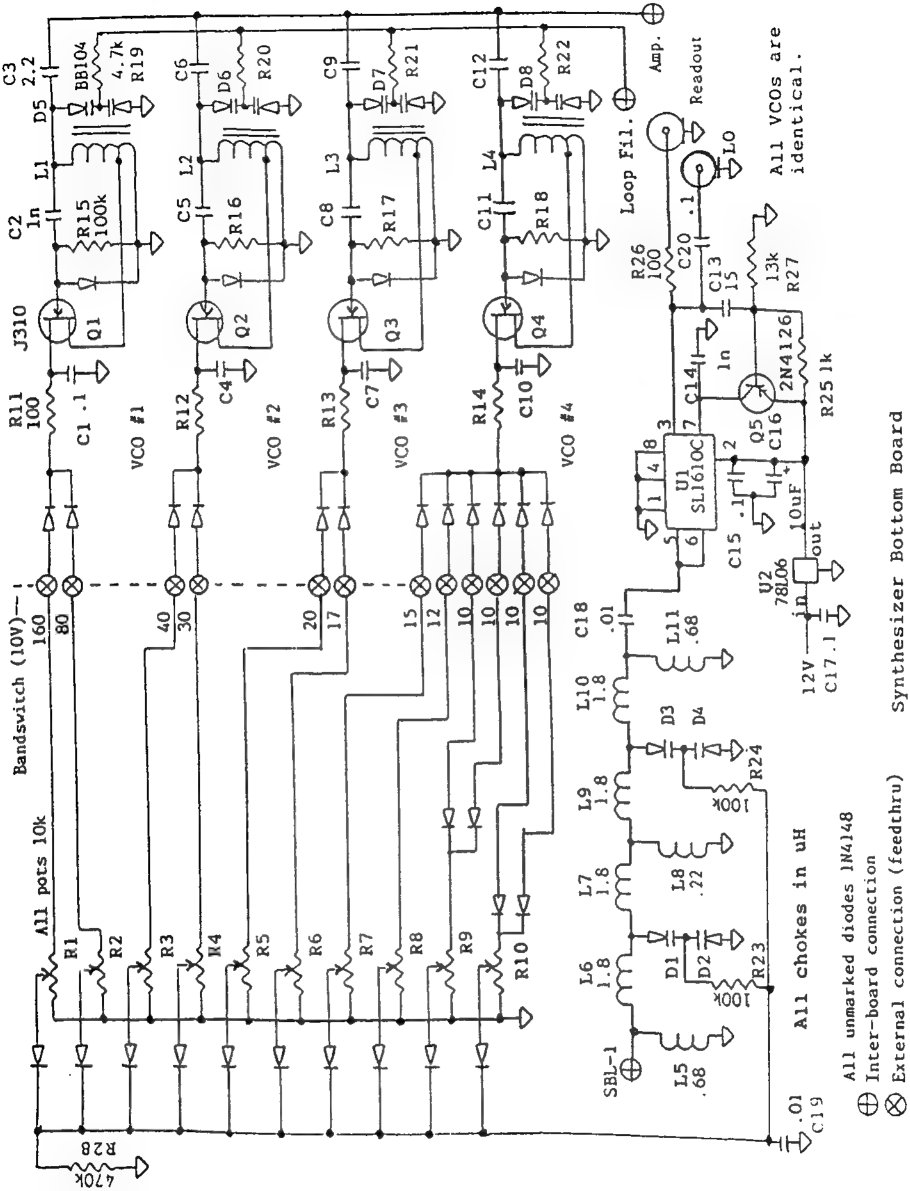
Synthesizer Top Parts Placement



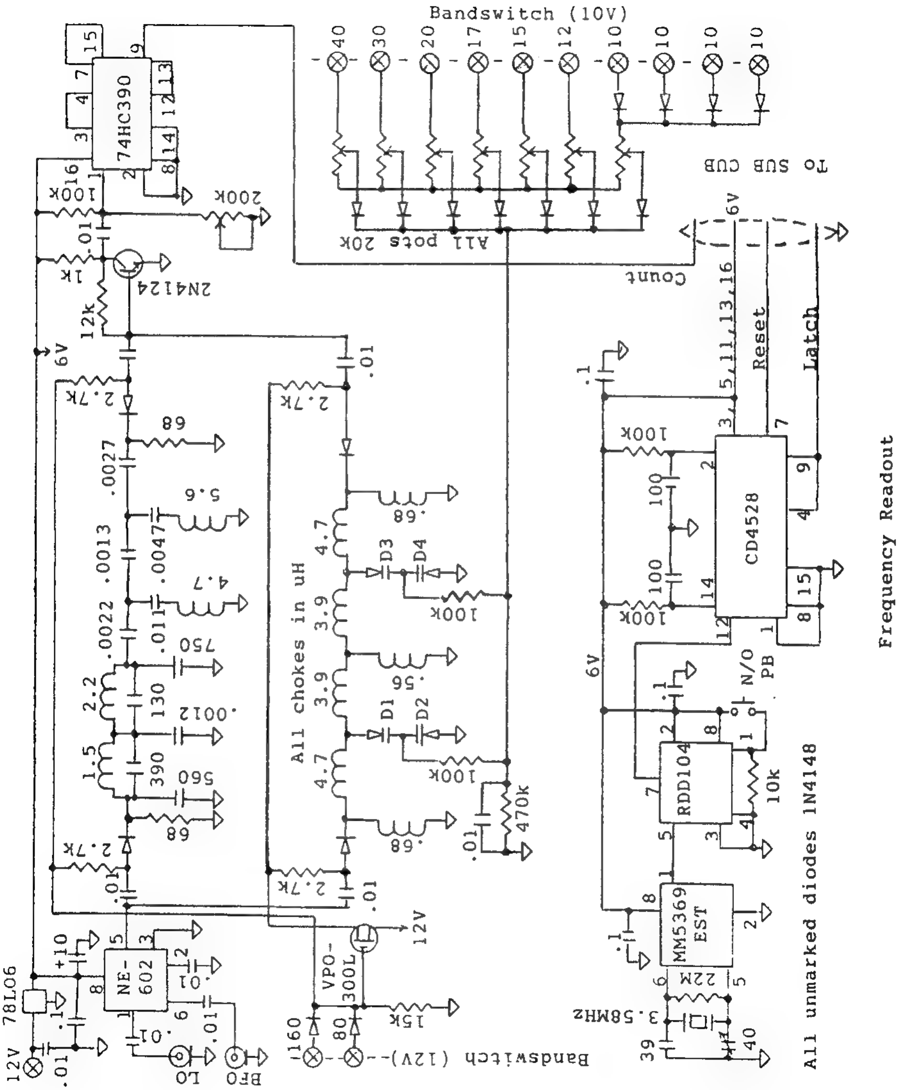
Sythesizer Bottom Parts Placement



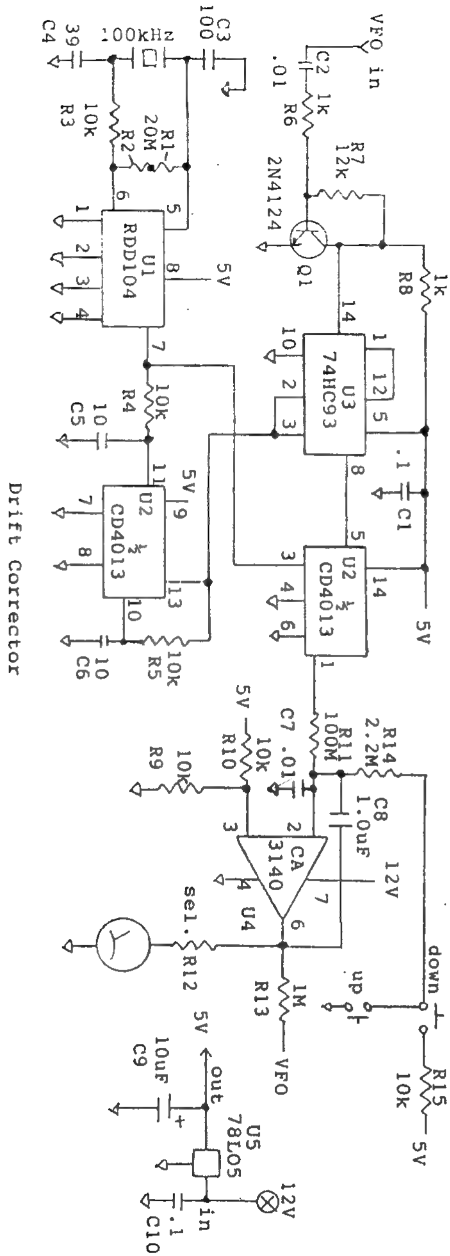
Synthesizer Top Board Schematic



Synthesizer Bottom Board Schematic



Frequency Readout Schematic



Drift Corrector Schematic

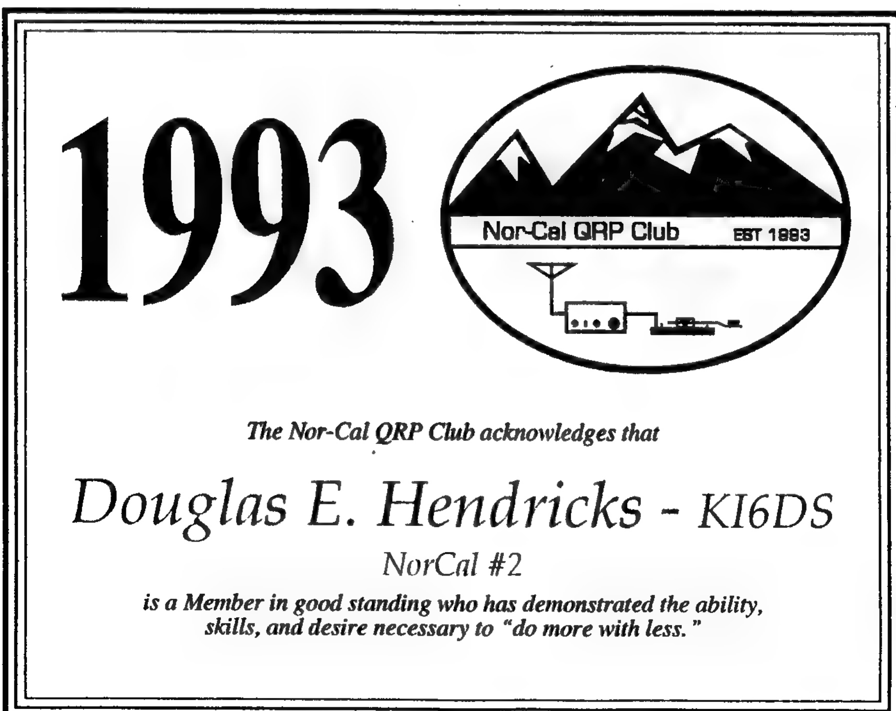
NorCal Membership Certificates Available

by Bob Finch, N6CXB
7530 Ridgeview Lane
Lafayette, IN 47905

I have available NorCal Membership Certificates that are laser printed and available for $2.50 postage paid. The certificates are printed on high quality paper in 2 colors, with your name, call, membership number and year of membership in red. The club logo and the rest of the lettering is in black. If you would like a certificate, please send your name and membership number to me at the address above along with a check or money order made out to Bob Finch for $2.50 and we will ship you your personalized membership certificate to NorCal in 3 to 4 weeks. The size of the certificate is 8.5" x 11", but it may be cut down to fit in an 8" x 10" frame. **DO NOT MAKE CHECKS OUT TO NORCAL!**

The certificates were designed by Jeff Stewart, KF9UP, and are provided as a service to NorCal by Jeff and myself. They are shipped flat in a 9 x 12 manilla envelope to avoid folds.

NOTE: Bob and Jeff offered to do this service for the club. I have seen the the certificates and they are absolutely beautiful. We did not want to raise the cost of joining the club ($0.00), so we decided that those members who wanted a membership certificate would pay for them, and those that did not, would not have to pay for something that they did not want. Thanks to Bob and Jeff for providing this service. A copy of the certificate is below.



1993

Nor-Cal QRP Club EST 1993

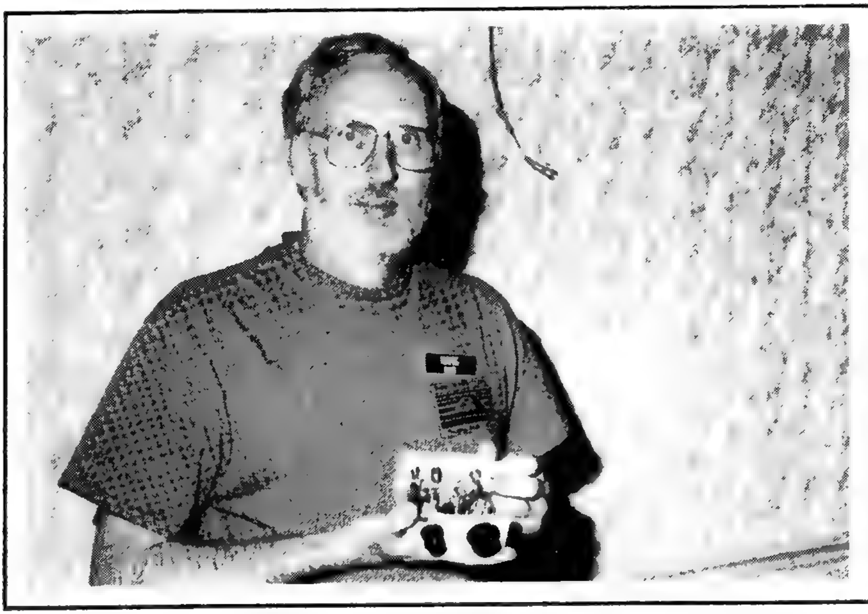
The Nor-Cal QRP Club acknowledges that

Douglas E. Hendricks - KI6DS

NorCal #2

is a Member in good standing who has demonstrated the ability, skills, and desire necessary to "do more with less."

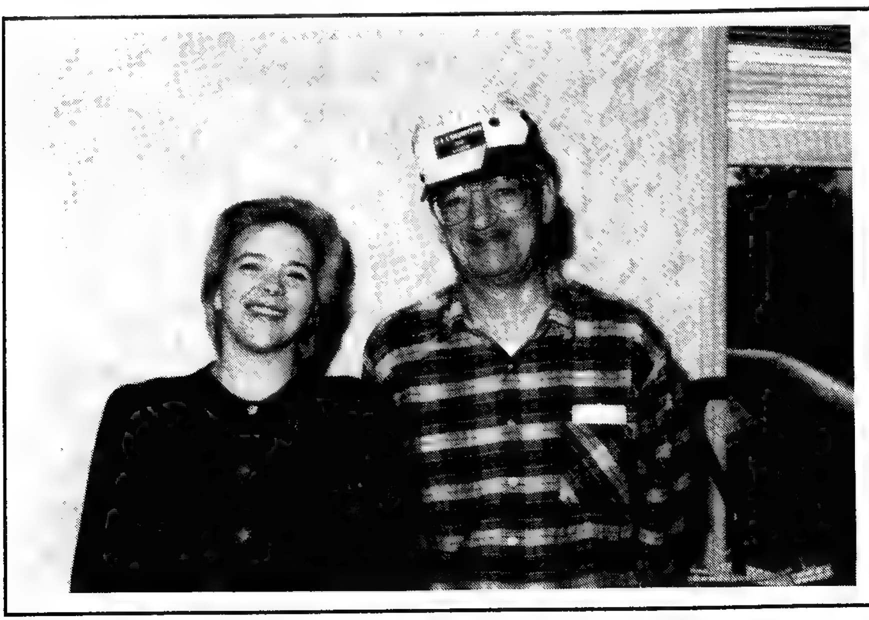
NorCal Membership Certificate



Dave Benson, NN1G with the Small Wonder Labs 40-40 CW Transceiver. Steve Hideg Photo.

The Cascade, NorCal's SSB Transceiver Kit, on display at Dayton. Steve Hideg Photo.

Doug Hendricks, KI6DS, Dave Gaulding, NF0R, and Keith Arns, KC0PP looking over the prototypes of the St. Louis Tuner. Steve Hideg Photo.



Cathy and Dick Sysmanzki, KA3ZOW from S & S Engineering. Dick is the designer of the ARK 40 & ARK 80 CW transceivers. Steve Hideg Photo.

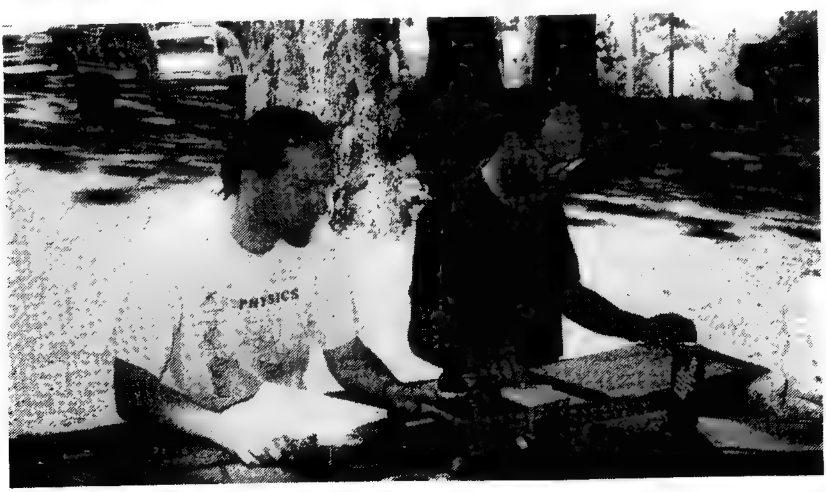
Field Day 1995

Field Day at Eagle Rock with the **NorCal QRP Club.** Eric Swartz, WA6HHQ at the top of the tower and Stan Goldstein, N6ULU at the base.

Photo: Stan Cooper, K4DRD

Wayne Burdick. N6KR and Cam Hartford. N6GA. at the 20 meter operating position for the **Zuni Loopers** at Field Day 1995.

Photo: Bob Heusser



Back Issues of QRPp

Back issues of QRPp are available in bound issues only. Volume I contains the 3 issues from 1993, and Volume II contains the 4 issues form 1994. Volume I is 140 pages and costs $10, while Volume II is 296 pages and costs $15. Both years are $25. To order, send your money to: Doug Hendricks, KI6DS, 862 Frank Ave., Dos Palos, CA 93620. Make all checks and money orders out to Doug Hendricks, and NOT to NorCal! DX orders please include $10 extra per order for postage. All prices are for US Funds only!

Curtis 8044ABMKeyer Chip and Far Circuits Board Combo

NorCal has made a bulk purchase of the Curtis 8044ABM Keyer Chip and is offering it with the Far Circuits Board and the Info Sheet for $17.00 Postpaid. DX orders add $5 shipping. US Funds ONLY!! Make Checks or Money Orders out to Jim Cates, NOT NorCal! Send your orders to: Jim Cates, WA6GER, 3241 Eastwood Rd., Sacramento, CA 95821.

7.040 Crystals

We have located a supply of 7.040 crystals in the small HC49 holders. These are on the QRP calling frequency for 40 meter CW. The price is $3 each, or 4 for $10, postage paid. Make Checks or money orders out to Doug Hendricks, NOT NorCal. Send to: Doug Hendricks, 862 Frank Ave., Dos Palos, CA 93620.

NorCal QRP Club

QRPp is published at Dos Palos, California 4 times per year: March, June, September, and December. Subscription fee is $10 per year for US residents, $15 per year for Canada, and $20 per year for DX. To join NorCal QRP Club send your name, call, and address to Jim Cates. There is no charge for membership to NorCal QRP Club. To receive QRPp, you must subscribe and pay the fees. Send your money (US Funds ONLY) to:

Jim Cates, WA6GER
3241 Eastwood Rd.
Sacramento, CA 95821

Make Checks or money orders out to JIM CATES, do not make them out to NORCAL.

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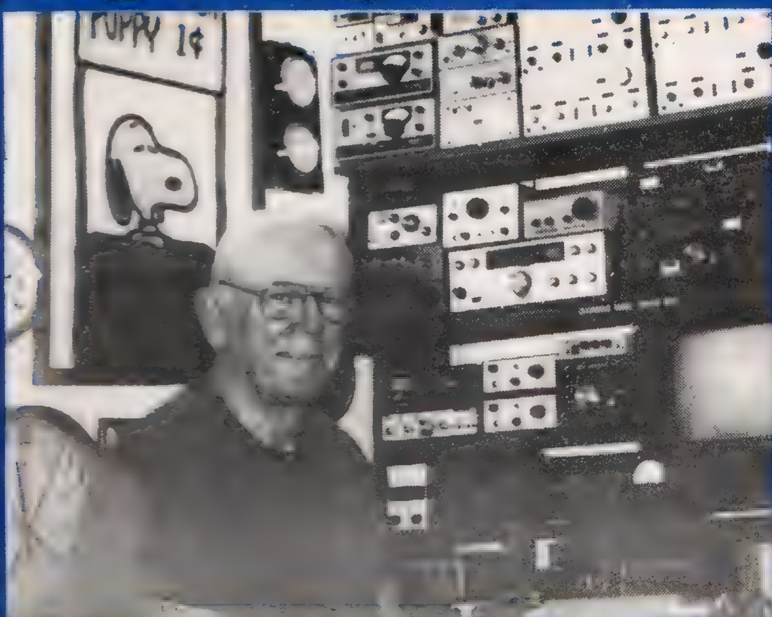
Volume III, Number 4, December 1995



Jim Cates, WA6GER
"A Gentleman"

Table of Contents

From the Editor

By Doug Hendricks, KI6DS
862 Frank Ave.
Dos Palos, CA 93620
Phone 209-392-3522
Email dh@deneb.csustan.edu

You will have noticed that Jim Cates, WA6GER, has his picture on the front of this issue. This is the first "Cover Picture" that I have done. I did it to honor a man who is my best friend, and is a friend to QRPers all over the world. He works many hours daily for QRPp, and I wanted to show my appreciation. The cover says, "Jim Cates, WA6GER, A Gentleman", and for all of us that know Jim personally, that describes him perfectly.

We have had an exciting fall in the QRP world. The Cascade has been born, and from the first reports is an outstanding success. John Liebenrood, K7RO and Dave Meacham W6EMD are to be congratulated for their design of a great kit. There have been many requests for more of the Cascades and I am pleased to announce that we have 50 more kits available. They will cost $199 each as we only kitted 50 this time and parts have gone up. If you are interested, see the announcement on page 66. Act fast, because when those 50 Cascades are gone, there will not be any more. John has decided to move on to other projects and he is not interesed in making the Cascade a commercial venture. If you want one, order fast.

We are announcing that we are now taking orders for the St. Louis Tuner. This tuner is a cooperative venture between the St. Louis QRP Club and NorCal. See page 66 for ordering information. We will kit 250 of these and they will go fast. This is the first announcement and we did it in QRPp because we want to give the first chance to our members. Note that the variable capacitors are now custom air variables and not the plastic am radio ones.

The Cascade construction article by John is printed because we realized that even though 200 club members bought the kit, over 1200 did not, and they have not had the opportunity to see the design. I felt that the rest of the club deserved to see John's work. IT is and was an outstanding effort.

NorCal and ARCI had a booth at Pacificon again this past October, and it was a chance for many of the NorCal members to get to meet each other and have that eyeball QSO that we seem to need.

Jim and I decided last spring that one of the best ways that we could put club money to use was to sponsor the speakers for the QRP Forums. We contacted Dick Brown of Pacificon, and he agreed to give us the large lecture room if we would agree to supply "World Class Speakers". We did that by having John Liebenrood, K7RO the designer of the Cascade, Derry Spittle, VE7QK, the designer of the Epiphyte, speak on SSB on Saturday. And then we came back with Wayne Burdick, N6KR, the designer of the NorCal 40, Sierra, and KC1 and Stan Goldstein, N6ULU, who has worked 113 countries with his NorCal 40 to speak on CW.

All four of the speakers were outstanding, and were presented NorCal Pacificon QRP Forum Plaques as a token of NorCal's appreciation for their efforts. Stan Goldstein was also presented a plaque for being the first to reach DXCC with the NorCal 40. (We are only going to give 1 plaque, and Stan has won it!)

Jim and I both feel that this is an excellent project for NorCal, and we plan on it again next year. We are even thinking of sponsoring a full day of QRP forums, sort of a West Coast QRP Symposium, with speakers from the BC QRP Club, NW QRP Club, the Arizona QRP Group, and the Southern Cal QRP guys. It would be held in conjunction with Pacificon, and NorCal would rent a room for forums during the day and then have a hospitality room "a la Dayton" in the same room at night. Let Jim know what you think of the idea.

Jim Cates, WA6GER, "A Gentleman"

I asked Mac to write this biographical sketch because he is one of Jim's oldest and dearest friends. He knows the early history of Jim Cates and his ham radio career as well as anyone.

This issue is dedicated to the best friend that I have ever had. He has been a friend in every way. Jim is always the level headed one of the two of us. He is the one who keeps me under control and the one who prevents most of the mistakes that I would make in a rush of anger.

Jim Cates embodies the spirit of NorCal and of QRP. He is quiet, unassuming, gentle and the most giving person I have ever known. He spends countless hours working behind the scenes to make sure that NorCal QRP Club and all of our projects stay on course.

Jim is the first to have his Picture on the cover of QRPp. I don't know if anyone else ever will. This article was written and this issue is dedicated to Jim Cates, WA6GER without his knowledge. Hopefully, he will like it. Doug, KI6DS

Laissez Faire Exemplified

by D.J. "Mac" MacDonald
2129 Danbury Way
Rancho Cordova, CA 95670

No, I'm not talking about laziness. Though I have been told I personify it and that is just because I have spent a large part of my life studying it first hand. What I am talking about is the principle of minimum authority whether of government or in this case club organization and operation.

NorCal members and readers of the QRPp journal might be interested in a brief status report on the club and a short biography of one of its two founding fathers, Jim Cates, WA6GER. His concept of *Laissez Faire* and its implementation in the organization and operation of an amateur radio club.

NorCal QRP was conceived by Jim Cates, WA6GER and Doug Hendricks, KI6DS. They thought that they might be able to find 15 or 20 hams who were low power fans to form a club. Jim, having spent 33 years in government and knowing full well its faults and weaknesses wanted nothing more to do with rules, regulations, charters, by-laws or what have you. In addition, being born in Texas he was (and is) a natural born rebel; though he denies that his bed sheets are in the pattern of the Confederate flag. Doug, KI6DS, our editor, being a Kansas Jayhawker, (you remember them from your US history) is of the same ilk. I could have said mindset, but those of you who know Jim and Doug undoubtedly recognize the accuracy and veracity of the above.

This club, they said, would have no constitution, no charter, no by-laws, no officers, no dues, no business reports or formal meetings and no minutes. Each member is equal to every other member. Therefore any member can do what he or she wants. Though there are no dues, there is a subscription fee if a member wants to receive the quarterly publication.

So what has happend? From the 15 or 20 hams initially expected, the club now has over 1450 members in 48 states and 31 countries with members on every continent except Antarctica. We have members from Spain to Siberia, China and to Malaysia, Australia and Oceania, Alaska to Argentina. Could it be that the principle of *Laissez Faire* as practiced by our club has struck a responsive chord world-wide? The other possibility is that we may be a club of 1450 Rebels and Jayhawkers. Naw, that couldn't be, because hams by nature are very submissive and would never think of a different way of doing things from the tried blue, cast in concrete, already proven concepts.

So who are these guys, Jim and Doug,

who have shepherded NorCal QRP Club to its current prominence in the world of QRP? This is a short biography of Jim. Doug's will follow at a later date.

Jim Cates, WA6GER, born in Lufkin, Texas, was the second of three sons born to Charles and Lottye Cates. Born in 1926, he was educated in the public schools of Texas graduating from high school in 1942, four days past his sixteenth birthday. He joined the U.S. Navy in 1943 and after attending a Navy school was assigned to the Alameda Naval Air Base, Oakland, California as an Aviation Ordinanceman. While stationed there, he met Electra in 1944 and married her in September of 1945. Two sons, Steve, KC6TEV, NorCal Awards Chairman, and Jack, ex-WB6OEP, were born of this union. And this year Jim and Electra celebrated their 50th wedding anniversary.

Upon discharge from the Navy in April of 1946, Jim entered the University of California, Berkeley. Three years later, 1949, he graduated with a degree in Journalism andproceeded to go to work in Modesto, California as a Probation Officer. One year later he and Electra returned to Oakland, California to work for the Alameda County Probation Department (higher pay). Then, in August of 1953, Jim joined the California Adult Parole Division in Sacramento, California.

As a Parole Officer Jim: carried a caseload of adult felons; was Assistant Supervisor and later Supervisor of the Sacramento District Office; Assistant Supervisor of the Interstate Unit, responsible for arranging the supervision of all California parolees paroled out of state and, when necessary, their extradition. He was also Interim Regional Administrator for the area from the southern Oregon border to the northern Los Angeles county line, from the east side of the Coast Range Mountains to the Nevada state line. Through Jim, and his most able assistant, modesty forbids my mentioning his name, Region I set a standard of excellence that to this day has not been equaled in the parole division.

In 1959, inspired by lunch time conversation between Bob, ex-K6SDH and K6AGN, both Parole Officers, Jim became WV6GER. Motivating one to be all one can be (a phrase I am sure the Army copied) was carried to the nth degree when Jim became enamored with ham radio and electronics.

After his first CW contact on the Knight Receiver he built there was no stopping him. He built kits, modified surplus Air Force gear (MARS) and home-brewed. He is a CW aficionado, has owned and operated AM, FM, SSB, 2 meter, 6 meter, 220, 440, 1296, RTTY, ATV, and packet gear. The only thing he hasn't done as far as I know, is moon bounce and he is looking into that. I might add that as expected, he has WAS, WAC, DXCC, and has won a number of Field Day Contests. His true love and burning passion though is QRP. As proof thereof, take a look at the operating position of his ham shack.

I feel that I would be remiss if I failed to touch on his finest quality, helping others. The Greek philosopher, Sophocles, wrote, "It is but sorrow to be wise when wisdom profits nothing". After choosing and spending a career of 33 years helping others he switched "clientele" and became an ELMER to multiple others repairing sick rigs, teaching code, helping raise antennae, and much,much more. Personally I doubt if he has ever given much thought to it but his own philosophy and guiding principle has to be, "Help where help is needed".

So there you have it, a brief sketch of a very talented guy, one who after spending a career in public service continues to use his time and talents in ways that enrich the lives of others. Many of us who know Jim have been and continue to be the beneficiaries of his sensitivity, thoughtfulness and helping hand. CU K6AGN es 73

The Cascade:
A 20/75M SSB Transceiver

by John Liebenrood, K7RO
1650 NW 130 Ave.
Portland, OR 97229
k7ro@teleport.com

I have always wanted to design a SSB Transceiver, but have not done so due to time constraints and lack of encouragement. My strength is in circuit design, but packaging is one of my weaknesses. In the fall of 1994, I posted a description of the R2/T2 design by Rick Campbell that I had built on the QRP-L list on the internet. Doug Hendricks contacted me and encouraged me to write a full fledged article for QRPp. I did so and the article was published in QRPp and later in Sprat.

Doug and I made a trip to Vancouver, British Columbia to meet the members of the BC QRP club who have been experimenting with SSB QRP rigs for over 10 years. We met Derry Spittle, VE7QK, Bruce Gellatly, VE7ZM, and Joe Stipek, VE7TX and others who are heavily involved in the design and operation of SSB QRP rigs. The trip inspired me. I picked up a lot of tips from Joe, Bruce and Derry, and I on the way home I asked Doug if NorCal would be interested in a SSB club project. I would design the rig, but would need help with the packaging and the writing of the manual. Doug had brought along a Sierra, which was the second NorCal club project and is an absolute work of art in its packaging design. We discussed the possibility of a SSB rig of my design in a Sierra style case. Doug said that he would have to talk it over with Jim Cates, WA6GER, the cofounder of NorCal, but he didn't think it would be a problem.

The next evening Doug called with good news. Jim thought the idea had a lot of merit, and there had been a lot of requests for a SSB rig. They gave the go ahead on the condition that the following conditions would be met.

1. The rig had to meet NorCal standards.
2. I would have to build a working prototype deadbug style.
3. NorCal would pay for all research and development costs.
4. NorCal would have one of their design people go over and evaluate the design.
5. It had to be a circuit board designed project that used a gerber file.
6. The prototype had to be finished by Dayton.

I went to work and started the design process. The following is the result of hundreds of hours of work, but was also a labor of love.

The first thing that you should do when you decide to produce a kit or club project is set paramaters. Doug and I set the following goals for the Cascade:

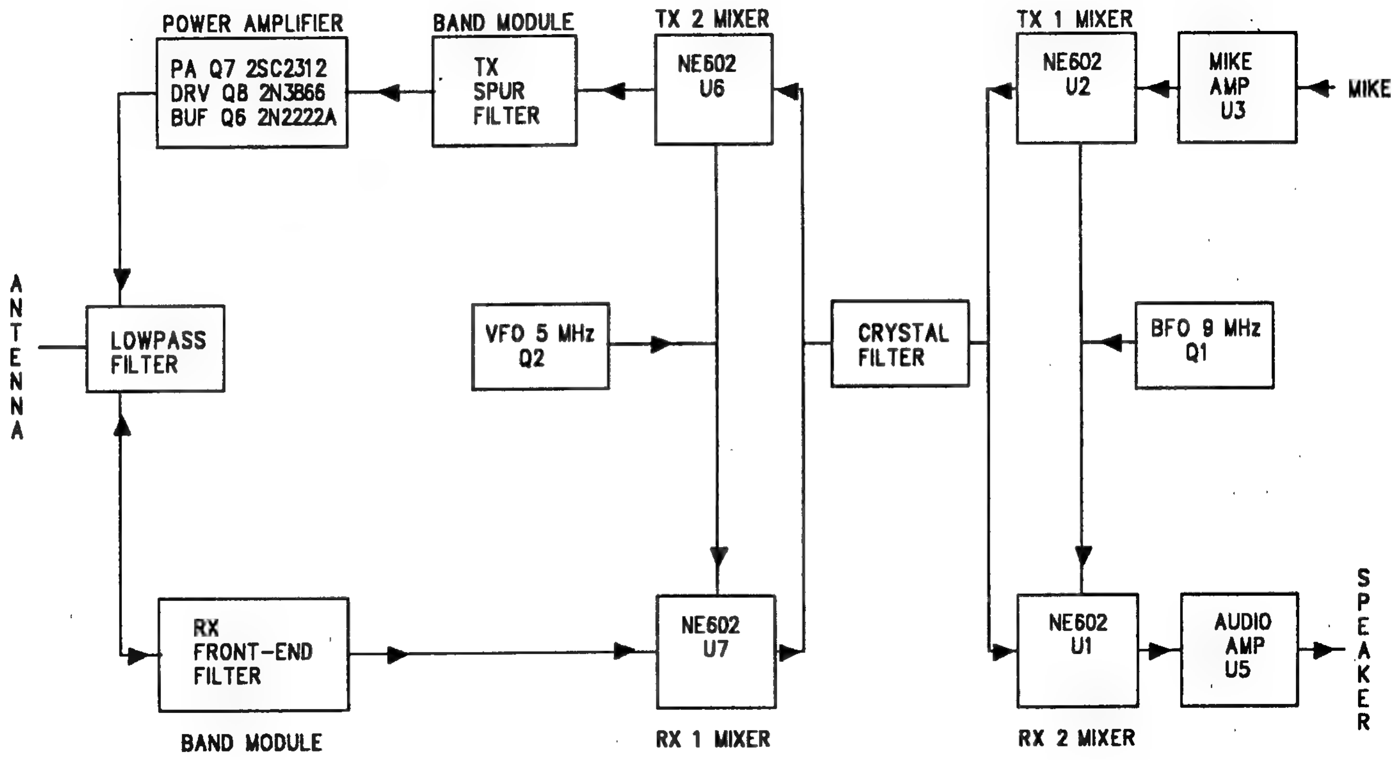
1. Simple to build.
2. Stable, VFO controlled, 200 kHz coverage.
3. Small in size, easily adapted to portable operation or bike hiking.
4. NorCal type packaging (No wires to connectors, easily accessible case.)
5. Inexpensive (Less than $200 for complete kit.)
6. Dual Band Coverage 20/75 Meters. 20 Meters for daytime use, 75 Meters for night.
7. Homebrew SSB filter using common, cheap, easily obtainable computer crystals.
8. Meet FCC specifications for spectral purity.

Circuit Description

A valuable technique in RF trouble shooting is tracing the signal path. We'll trace both the transmitter and receiver signal paths separately. This section will also try to clear up how all the schematics link together.

As a starting point, look over the Cascade Block diagram on page 4. The receiver circuitry starts at the BNC antenna jack, goes through the low pass filter on the band module card, into the receiver pre-selector filter, back on to the main board to the 1st receiver mixer, through the crystal filter, then the product detector and finally to the

CASCADE: K7RO QRP SSB TRANSCEIVER BLOCK DIAGRAM



audio amplifier.

The SSB transmitter circuitry starts at the microphone input, goes through the microphone amp into the 1st transmitter mixer, back through the crystal filter, then to the 2nd transmitter mixer, transmit spur filter, power amplifier chain, back on to the band module lowpass filter, and finally out the BNC jack to the antenna.

Tracing the SSB Receiver Signal Path

Turn to the Power Amplifier schematic in the insert. Find the BNC jack J5. It connects back to the lowpass filter on the plugin band module board. The actual circuit values are shown on the band module schematic. Once through the lowpass filter, the signal passes through a narrow band pass filter consisting of C1, L1, T1, & C2. Turn to the IF Crystal filter schematic on in the insert. Find the 'flag' text "RX FILTER". The flag on both schematics links the two together.

The signal loss through both these filter is low, less than 12% voltage amplitude reduction. Notice The 1K RF Gain pot connected between T1 and L1. The transistor Q1 shunts the receiver input to ground during transmit, protecting the 1st mixer IC.

The receiver pre-selector filter is adequate but not up to the task of protecting a NE602 in a field day multi-transmitter environment.

Next turn to the VFO, BFO schematic in the insert. Find Q2, part of a Hartley oscillator circuit. For 20M SSB phone band coverage, the VFO tunes 5.15MHz to 5.35MHz. It needs to be 100kHz lower to tune the 75M SSB phone band. Fixed caps C22 and C25 set the 200kHz band-spread, C17 sets the band edge. When the 75M band module is plugged in, C34 is added lowering the VFO 100kHz.

The 9Mhz BFO needs to oscillate above 9MHz for LSB and below 9MHz for USB. C19 sets the oscillator 2kHz above the IF for 75M LSB. When the 20M band module is installed D10 is bias on connecting C90 across C19. The addition of C90 lowers the BFO below 9MHz. There is some interaction between these adjustments, set C19 first then C90.

The Cascade uses four NE602 active mixer ICs. Find U7, a NE602 used as the 1st receiver mixer. Turn to the IF Crystal Filter schematic in the insert. U7 converts incoming RF to the IF frequency with a voltage gain of 4. Q11 removes DC supply to U7 during transmit.

The 9MHz IF crystal filter uses 5 "computer grade" crystals, Y2 - Y6. These were matched to within 100Hz. For SSB fidelity a Butterworth transfer function was used instead of the common Cohn response for CW rigs. The bandwidth is a compromise between opposite side band rejection, carrier suppression and fidelity. The filter was designed using software provided with Wes Hayward's ARRL book "Introduction to RF Design". This book sells for $29.95 and is an excellent addition to your library. With this software you can redesign the coupling caps to suit your desired characteristics.

Next turn to the Product Detector schematic in the insert. The 9MHz IF is converted (with a gain of 4) to audio in U1, another NE602 mixer IC.

Now turn to the final receiver schematic, Audio Amplifier in the insert. Most of the receiver gain in the Cascade is at the audio range. The audio amplifier has two gain stages. U8, a low noise NE5532, provides a voltage gain of 22. U5, a LM383 provides an additional voltage gain of 1000. You'll notice there's no IF amp in the Cascade.

AGC is a circuit right out of the NORCAL Sierra. A JFET, Q17, attenuates S9++ signal to a reasonable audio level.

Q5, a MOSFET 2N7000, mutes the speaker during transmit. During receive, the on resistance is less the 3 ohms.

Tracing The SSB Transmitter Signal Path

Tracing the transmitter signal path

starts at the microphone input jack. Turn to the Product Detector schematic on page 19. Find J1, the front panel microphone jack. The radio accepts a "Icom standard" electret microphone circuit. These microphones have the PTT switch and microphone in series, the PTT switch completes the circuit to the ground terminal.

Q3 provide the 2V microphone bias and switches the 8VTX line during transmit. U3 provides a one chip speech processor. The chip samples the microphone audio and adjusts the gain to hold its output at pin 8 at a constant 100mV RMS.

More than 20dB of speech compression is possible. R4 sets the amount of compression. R4 is set at 1K, I set the compression at a moderate level, you may want to experiment with different settings. R1 and C86 set the attack and decay times. You may want to tweak the values for some more audio punch.

Next the signal passes into Q15. Q15 mutes the transmitted audio during receive. R63 is a fixed resistor, this is a good place to adjust the microphone gain. 4.7K is about right to drive the NE602. It is easy to over-drive the NE602 active mixer IC and end up with lots of out-of-band spurs.

U2, the third NE602, generates the double side band signal at 9MHz. Carrier balance would be improved if U3 pin 5 and 4 drove a balanced transformer into the crystal filter. For now it is a single ended drive, yielding 30dB of carrier balance.

Q14 disables the transmitter mixer during receive, this stops hiss from showing up in the audio due to the TX mixer.

The double side band RF next passes back through the IF crystal filter. Turn to the IF Crystal Filter schematic on page 20. The SSB filter removes the opposite side band and suppresses the carrier. U6, the final NE602 mixer IC, translates the 9MHz RF to the final transmit frequency with a voltage gain of 4.

The output of U6 pin 5 goes to the unity gain JFET buffer. The drives the 50 ohm terminated transmit spur filter. The transmit spur filter is on the band module card, refer to the band module schematic for circuit values.

Now turn to the final transmitter schematic, Power Amplifier in the insert. The transmit spur filter is represented in the bottom right corner. The filter is driven with baluns to improve spur rejection due to signal leakage around the band module card. Both transmit filters have low signal loss when properly adjusted. Both filters match into 50 ohm terminations. Once through the appropriate filter, the low level SSB signal is amplified in 3 gain stages. The first two stages are biased for Class A operation. This takes a fair amount of idle current. The final power amplifier transistor is biased for AB operation. With no signal the 2SC2313 should draw 200mA.

D12 maintains a constant bias current as the final heats up with use. D12, which is in physical contact with the case of Q7, temperature compensates the bias network. The 2SC2312 needs a low value emitter resistor to stabilize the bias network. This did reduce the power out some. A compromise was made to help keep the Cascade cost low. A low cost 2SC2312 was selected. For those wanting more output a MRF477 can boost the power out for an extra $18. RF Parts sells these via mail order.

The SSB signal next goes back to the band module board where the lowpass filter is located. The 75M lowpass filter has two extra caps, C13 & C14. These add a deep notch at the second harmonic of 3.8MHz, to attenuate the highest spur.

That is it, now you should have an understanding of the way that the Cascade works.

Cascade Specifications and Goals

Size: 2.6"(H) by 6.3"(W) by 5.3"(D)

DC Power requirements:

Receive: 60mA with 12 to 13.8V

Transmit: 2.0A on voice peaks, 12 to 13.8V

Frequency coverage:

75M SSB: 3.750 to 3.950 MHz (Can be set to any 200 kHz range on 75-80 Meters)

20M SSB: 14.150 to 14.350 MHz

Band-edge adjustment range: +/- 20kHz

Transmitter:

SSB only

Uses 2 Meter Speaker Mike "Icom Standard" or Radio Shack #19-310 (2.5mm mono mike plug, 3.5mm speaker)

75M LSB Power: 8 Watts pep

20M USB Power: 5 Watts pep

Speech compression

2 Tone IMD distortion products: -35dB

Spurious emissions: -45dB or better

Receiver:

NE602-Based Super-het, 9MHz IF

5MHz LC VFO, 200kHz tuning range with 8:1 vernier drive built in.

5 Pole crystal filter, 2.7kHz 3dB band width

Audio output power > 1Watt into 8ohms

Audio-derived AGC

RF gain control

Building the Cascade; Do's and Don'ts!!

1. Use a low-wattage, fine-tip iron, heat joint 1/2 second then apply small amount of solder.

2. The resistors are installed standing up, using 0.1" spacing. This was done to conserve board space. Since it will be hard to read the resistor color codes after the part is soldered in, CHECK! each resistor with an Ohm meter before installing it.

3. You must use solder-wick to remove parts. It is the only way to avoid lifing traces due to excess heating.

4. Double-check polarity before installing electrolytic and tantalum caps. With Electrolytic caps, the long lead is the positive side, it goes in the "square" PCB pad. With Tantalum caps, the positive lead is marked with a + sign on the body.

5. T1, T3, T4, T5 & T6 are all 8-Turn bifilar transformers on FT37-43 cores. Twist the two #26 wires (one brown, one green) at 8 twists per inch (use drill if you like). The brown wire goes in the "round pads" the green wire goes in the "square pads"

6. L1, the VFO inductor, should be annealed after winding. Place in boiling water for a few minutes remove and let dry, then coat with Q-dope to hold turns in place. Let dry overnight. L1 is ready to mount on PCB. Don't forget the black insulating washer for L7, it will prevent any shorts to the ground plane.

Construction:

There a several ways to assemble the kit.... One approach has you install all the resistors, then all the capacitors and so on. The testing starts after the board is populated. There are serious problems with this method, as you find out if you pursue it. The main one is that if you have problems it is hard to isolate.

NorCal prefers the build-a-section, test-a-section approach. This test as you go method helps isolate where the problem is... When seeking help you'll have the problem localized to one section. Getting the receiver working first, then adding the transmitter should help simplify trouble shooting when problems crop up..

Test Equipment Needed:

1. 12V power supply. 1.5A peak current demand
2. A speaker mike wireed for Cascade: 2 Meter "Icom" standard or RS #19-310
3. Voltmeter / Ammeter, 1mA resolution
4. General-coverage station receiver
5. RF probe for DVM to measure VFO, BFO and RF levels, or use 50MHz scope
6. HF frequency counter, or use station receiver
7, 10-watt dummy load, 75-meter antenna

The Cascade will be built and tested in ten sections. The first 5 sections get the receiver operating, sections 6 to 9 complete the transmitter portion, and section 10 deals

with the final assembly into the case.

Because of the building-block style of instructions, we have printed the schematic broken-down into several sections. That way you will only have to deal with the section that you are working on. If you want to get the "whole picture" you will need to refer to the blocked text on the schematic, which refers to the sheet that the connection goes to. Another word of caution here: make absolutely sure that you have the right part before you solder. It is not impossible to unsolder a double-sided, plated-through board, but it is not fun as you will find out if you have to do it. If you have inventoried your parts, read the complete manual and are ready, it is time to start with the fun part of building the Cascade. Good luck!!

Cascade Kits were made available to the club members last spring. We sold 200 of them in less than 5 weeks. As of the writing of this article in October, there are 50 more available at $200 + $5 shipping in the US, $10 DX. California residents please add 7.25% sales tax. Contact Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95841, Telephone: 916-487-3580 before you send your money.

It is possible to build this radio ugly construction style, because it was done that way first. If you are planning on buildig it "Ugly Style", you will need 2 band module boards which are available for $7 postage paid from Jim Cates at the address above.

SECTION 1:
DC POWER, 8V REGULATOR

Inspect the board to make sure that all connectors mount flush to the front and rear panels. If you need to file the board, now is the time to do it. Put the connectors on the board, but don't solder yet, and visually inspect to make sure that the front and back panels will fit flush to the edge of the board. This is extremely important for the final appearance of your rig.

When you are satisfied that the contrls will fit the board correctly, mount the following controls and jacks flush to the board edge: C18, J1, J2, J3, J4, J5, R19, R27, R49, S2. Do not install the front and rear panels at this stage, these will be used in step 10.

Don't wire in RG-174 coax to the RF gain pot yet. We'll add a temporary wire jumper to bypass the RF gain control later.

Install 8V regulator U4 and C27, C31, C32, D3, D4 (100 ohm resistor), Q3, R18, R20. Note that C28 is not used and will be left empty. Also, mount a 100 ohm resistor where D4 is indicated. Please refer to the diagram for parts placement.

Mount two board-support brackets, one next to J2 right above where it says R39. Make sure that the bracket is flush with the edge of the board. Mount the other bracket next to J1. Use 6-32 hardware to secure the bracket to the PCB.

Be careful when you solder the BNC jack. It is quite susceptable to heat. It has a tendacy to melt if you apply too much heat.

We are now ready for our first test. Plug in power to the power jack and turn S2 on. Monitor the input current. If it is over 20 mA shut off the power quickly as you have a short. Plug-in the 2-meter speaker Microphone "Kenwood Standard", push the PTT button and confirm the 8TX line goes to 8V DC. Measure 8TX on the collector of Q3. Do not go on until you have confirmed this check.

SECTION 2:
BFO

Install C19, C23, C24, C26, C30, C33, C90, C91, D2, D10, L2, L3, L33, Q1, R15, R17, R22, R59, Y1. Note that R58 is not used and left open. Refer to the VFO/BFO schematic, the BFO is in the upper left. Refer to BFO placement drawing on the next page for this section. NOTE: Identify trimmer C90 by a blue marking on the adjustment slot, trimmer C19 has no color marking on the adjustment slot. Bend C26, C23 leads carefully to fit wider PCB spacing. Also, make sure that you leave about

.025" spacing between Y1 and the surface of the board. Be sure to check the capacitor marking and identifying section before you install caps. It will save you headaches later. L3 and L33 must be mounted in an unusual way. They need to be mounted at a 90 degree angle to each other. Take the 2 coils and twist their leads together and solder so that they look like the view in the drawing. See drawing on how to mount L3 and L33. Mount L33 in the hole for L33 that is closest to the band module. Mount the other end of L3 to the hole that is closest to the front of the board for L3.

Check J2 input current, verify the BFO output voltage level at the junction of R22 and R58 is 600mV peak to peak. One can measure the BFO freqency by zero beating with the station reciever or use a freqency counter attached to R22.

Initial BFO Alignment:

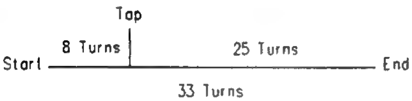
1. Adjust C19 to set 75M BFO frequency at 9.001MHz.
2. Plug-in blank 20M band module PCB into J4
3. Now Adjust the 20M BFO frequency to 8.998MHz
4. Remove 20M band module PCB

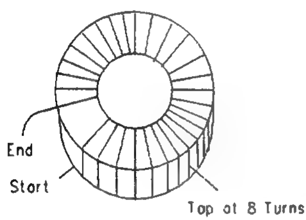
SECTION 3:
VFO

Install VFO components: Q2, C16, C17, C18, C20, C21, C22, C25, C29, C34. C89 is not used, short out with wire jumper. Next install R14, 16, 21, and 57. Note: when installing C18, use the 4-40 screws with the pan heads and the self contained washers. Make sure that the capacitor sits flat on the board and is flush with the edge of the board. If the cap does not sit flat on the board, take a file and run it over the bottom of the cap until the cap sits flat. Also, note that C20, C21, C22 and C25 are all NPO caps. They are disc caps and they have a small black dot on the upper edge.

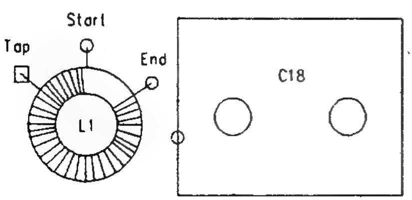
Now we are ready to wind our first coil, L1. Don't worry, despite what you have heard, it is simple to wind coils. When you finish this kit you will be an expert. Here is how to start. You will find 3 coils of wire in your kit. One is green and two of them are brown. There are 2 different sizes of the brown wire, #26, and #28. The #28 wire is the one that we want to use for this coil. It is the smaller diameter of the two. Cut off a piece of the #28 wire that is 36" long. Prepare one end of it by taking a match or cigarette lighter and burning off the insulation for about 1". Then, take some fine-grit sand paper and run the end of the wire through the sand paper until it is nice and shiny. You should take about 1" of the insulation off this way. Now, pass the wire through the toroid from the bottom and towards you. Then, hold the wire so that the start of the insulation is flush with the edge of the toroid and you have the 1" non-insulated bright piece hanging off the toroid. I like to hold this in my left hand. With the right hand, grasp the other end of the wire and start winding the toroid, being careful to not wind it too tight, but firm. Each time the wire passes throught the center of the "donut" counts as one turn. So, the first time you put it through was 1 turn, and now you have just put it through again for the second one. Do this until you have passed the wire throught the toroid 8 times. Next make a loop with the wire about 1" long. Give the loop 2 twists right against the outside edge of the toroid. This will become the tap. Continue winding until you have wound 33 total turns of wire through the toroid. Look at the diagram. Count the number of turns that go through the toroid, and remember that the first one counts! You should have a total of 33"wires" going through the hole. Leave a lead of about 1", and cut off the excess wire. Now, unwrap one turn. Get the cigarette lighter out again and burn off another 1" of insulation and clean with sandpaper as you did before. Don't forget to put the turn back on after you finish with cleaning it. The last thing is to clean the insulation

off the tap. To do this, hold it over the flame from the cigarette lighter but be careful not to burn the windings of the coil. You just want to clean the insulation from the tap. Use the sand paper to make the wire nice and shiny. The next operation will seem silly to your wife, but it makes for a stable VFO. Take the coil assembly and anneal it by placing in boiling water for 5 or 10 minutes. Take it out of the water and let it cool naturally. Coat the entire coil with Q-dope and let it dry overnight. Now tin all 3 leads with solder, and you are ready to install it.





To install the toroid, you will use the nylon hardware. Take the nylon 6-32 screw, place it through the black shoulder washer, then through the toroid, then through the black insulating washer, and finally through the pcboard. The start of the winding that is closest to the tap goes into the middle pad, the tap goes into the square pad on the left and the other end goes into the pad nearest C18.



When all wires have been placed correcty, place the nylon 6-32 nut on the back of the board and tighten. It doesn't need to be too tight, but it does have to be firm. Make sure that the wires are pulled through the pc board, and solder.

L1 measures 5.1uH between the start and end. If you have an inductance meter verify the inductance value.

Check J2 input current, verify the VFO output voltage level at R57 is 600mV peak to peak. One can measure the VFO freqency by zero beating with the station reciever or using a freqency counter attached to junction of R21 and R57 at Pad 12.

VFO Alignment

1. Set both C17, and C34 to Half Meshed position
2. Set C18 to Fully Meshed position
3. Measure LO using station reciever, should be around 5.150MHz. Write down this frequency value.
4. Install blank 75M band module PCB into J4
5. Subtract 100kHz from frequency in step 3 above. Now adjust C34 so the VFO now oscillates at this new lower frequency. This shifts the VFO when changing bands.
6. Remove 75M band module in J4
7. Adjust C17 for 5.150MHz..... This is the tough part. You'll need to squeeze turns on L1 if C17 doesn't have enough range

VFO Alignment Tips....

1. Removing one turn on L1 shifts the VFO UP 180KHz
2. C34 needs to be about half meshed when finished.
3. L1 inductance should be 5.1uH

After leaving the VFO on for a few minutes, confirm the frequency drift is less than 100Hz shift in 3 minutes.

SECTION 4: AUDIO AMPLIFIER

Install Audio amplifier components C35, C37, C38, C39, C40, C41, C42, C43, C44, C46, C47, C94, C95, C97, C98, D5, D6, D7, D8, D11, Q5, Q17, R24, R25, R26, R27, R28, R55, R56, R64, R65, R67, R69,

R70, R71, R72, U5, U8.

Carefully take a pair of needlenose pliers and bend leads on U5 TDA2002 to fit PCB holes. Do this gently and check for a fit. When installing 1N914 diodes, the "band" end goes in the PCB square pad. C47 and C98 are non-polarized capacitors. They look like electrolytics, but they are "non-polarized", it does not make any difference which lead goes where.

When all audio-section parts have been installed, set R64, the AGC threshold trimpot to mid-range.

Check J2 input current is less than 70mA. Rotate the volume pot R27 to fully clock-wise position. Confirm a "hum" is present in the speaker when touching R27 wiper pin with your finger. The "hum" should drop out when the PTT button on the Mike is pressed. (Be sure to plug in the speaker Mike for this test!!) U5 runs warm to the touch, you may want to add a heat radiator (not supplied with kit).

SECTION 5: IF AND PRODUCT DETECTOR

Install C1, C2, **C3 [NOTE: the drawing and the parts screen shows the leads for C3 reversed. The positive lead of C3 goes to pin 2 of U1]**, C4, C5, C6, C7, C8, C9, C11, C12 **[Note: the drawing and the parts screen shows the leads for C12 reversed. The positive lead of C12 goes to pin 7 of U3]**, C13, C14, C68, C69, C70, C71, C72, C74, C75, C76, C79, C84, C85, C86, C87, C88, C92, Q11, Q13, Q14, Q15, Q16, R1, R2, R3, R4, R5, R6, R7, R9, R10, R11, R12, R47, R48, R51, R52, R60, R61, R62, R63, U1, U6, U7. Refer to IF and Product Detector Schematics

Install Q10, a 2N4124, and R50 near J4. Install 5 crystals and 6 silver mica capacitors C78, C77, C82, C83, C81, C80. The crystals are matched to within 100 Hz. and are in a small envelope. Make sure that you install all five of these crystals in the filter. The loose crystal in the bag of parts is the BFO crystal. Leave a small space (0.025") between the PCB and the case of each crystal. It isn't necessary to ground the case of each crystal to the ground plane. Also populate T4 , T5. (Winding instructions on page 11). Wait until step 7 to populate the the TX Mixer 1, U2 and Mike Amp U3.

Check J2 input current is less than 70ma. Verify DC levels at all NE602's pin 8, should be 6.5 to 7.5 volts. Confirm Q13 source voltage is 1 to 2 volts. Verify +8TX is 7.5 to 8V volts when PTT is closed Install a temporary wire jumper between W1 and W2. This bypasses the RF Gain POT, and will be removed later.

Use the station transceiver to transmit a low level signal into the station antenna on 3.800MHz. With a clip lead for an antenna on U7 pin 1, adjust the VFO to 5.2mhz. Verify a tone is present in the speaker.

SECTION 6:
PLUG IN BANDMODULES

20 Meter Band module:

Install vertical mount trimmer capacitors C1, C2, C6, C8 and C3, C4, C5, C9, C10, C11, C12, C15, C16. Now you will get another chance to improve your skill at winding toroids. But these are easier than L1, as they don't have a tap. Prepare the wire as in L1 and wind the following toroids using the same procedure to count the turns and then finish the toroid.

L1. Use a small yellow toroid (T37-6) and wind it with 31 turns of #28 Brown wire.

L2. Use a small red toroid (T37-2) and wind it with 12 turns of #26 Brown wire.

L3 Use a small red toroid (T37-2) and wind it with 12 turns of #26 Brown wire.

L4 Use a small red toroid (T37-2) and wind it with 14 turns of #26 Brown wire

L5 Use a small red toroid (T37-2) and wind it with 14 turns of #26 Brown wire

T1 Use a small Yellow toroid (T37-

6). You will have 2 separate pieces of wire for this one. The first is to be the secondary and is 31 Turns of #26 Brown wire, the primary has 3 turns of Green #26 wire.

Wind the secondary first, then wind the primary over the secondary.

75M Band Module Assembly

Install vertical mount trimmer capacitors C1, C2, C6, C8 and C3, C5, C7, C9, C11, C12, C13, C14, C15, C16. Now you will get another chance to improve your skill at winding toroids. But these are easier than L1, as they don't have a tap. Prepare the wire as in L1 and wind the following toroids using the same procedure to count the turns and then finish the toroid.

L1. Use a small black toroid with no marking (FT37-61) and wind it with 30 turns of #28 Brown wire.

L2. Use a small red toroid (T37-2) and wind it with 23 turns of #26 Brown wire.

L3 Use a small red toroid (T37-2) and wind it with 24 turns of #26 Brown wire.

L4 Use a small black toroid with no marking (FT37-61) and wind it with 12 turns of #26 Brown wire.

L5 Use a small black toroid with no marking (FT37-61) and wind it with 12 turns of #26 Brown wire.

T1 Use a small black toroid with no marking (FT37-61). You will have 2 separate pieces of wire for this one. The first is to be the secondary and is 30 Turns of #28 Brown wire, the primary has 2 turns of Green #26 wire.

Wind the secondary first, then wind the primary over the secondary.

Band Module Alignment:

Now we are ready to do some aligning. Install the 75M bandmodule. Verify VFO frequencies listed in step 3 again. Connect the 75M station antenna to the Cascade. Now peak the band module preselector caps C1, C2 for strongest back ground noise level. Tune in a station and re-peak C1, C2. Receiver should be functional at this point, adjust BFO for best audio quality. (Make the received signal sound normal. This is best done by listening to someone whose voice you know.) Write down your BFO freqency.

Repeat with 20M bandmodule installed. Peak 20M bandmodule preselector caps C1, C2 for strongest back ground noise level. Tune in a station and re-peak C1, C2

Tune in a "strong" S9 plus signal on the band, verify Q17 gate voltage drops from 3 to 4 volts down to 2 to 3 volts. Confirm receiver audio mutes when PTT is closed. Verify RF gain pot operates correctly. This completes the reciever section. Resist going on until you are satisfied the receiver is working properly.

SECTION 7: MICROPHONE AMPLIFIER

Install Microphone amplifier components, C10, Q12, U2, U3. Leave R8, C15, R13 out, they are not needed with the Radio Shack speaker mike. All the parts on the Product Detector schematic should now be populated. **Note the C12 polarity pad is wrong, plus side to U3 pin 7.** Note 22uF electrolytic caps aren't marked for polarity. SHORT LEAD is negative. Insert LONG lead into SQUARE pads.

Testing:

Connect a Kenwood or Radio Shack 2meter Speaker Mike. Verify the "MIKE" pin on J1 pin 2 is 2V DC when the PTT button is closed. Check U3 DC levels at pin 8 is 1 to 2 volts. Close PTT, speak into mike, confirm audio level at U3 pin 8 is at least 75 to 125mV peak to peak. Adjust R7 for equal DC voltage on U2 pin 1 and 2. This gets the carrier balance close.

SECTION 8: POWER AMPLIFIER

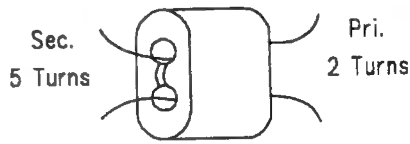
Install PA chain components: C49, C50, C51, C52, C53, C55, C56, C57, C58, C59, C60, C62, C63, C64, C65, C66, C67, D12 [**Note: Install D12 vertical with the**

banded end closest to the board. See drawing in Section 9 for details.], L4, L5, Q6 **[Note: The PCB screen is wrong for the type of 2N2222 transistor that we supplied. There is a tab on the metal can 2N2222A, it should point towards the Q6 on the parts layout]**, Q8, R31, R32, R33, R34, R36, R38, R39, R40, R41, R42, R43, R44, R45 **[Note: their are 2 trimpots in the kit. One is marked 500, it is a 50 ohm pot and is a mistake. Use the blue trimpot marked 501, it is the correct value, 500 ohms]**, R46, R99, T1, T2, T3, T6. Install 75M band module in J4.

It is time to wind some more toroids, and you are about to learn another skill. This time you will be winding a bifilar toroid, which means that you will use two different colors of wire. The kit is supplied with 3 rolls of wire, a brown #26, a brown #28, and a green #26. You will use the brown #26 and the green #26 to wind the bifilar T1, 3, 4, 5, & 6. The #26 brown wire is the larger of the two brown wires in diameter. Cut off a 10" piece of each wire, prepare one end of each color as before, and then holding the two prepared ends together, twist the two wires so that there are about 8 twists per inch. When you finish, wind the toroid with 8 turns and then prepare the ends as before. The easiest way is to unwind 1 turn after you finish winding, prepare the ends, and then put the turn back on the toroid. You will place the brown wire ends in the round pads and the green wire ends in the square pads.

Install a heat sink on Q8. It is the TO5 style and is round. If you have some heatsink compound, it would be a good idea to put some on.

Next we will wind the PA output transformer, T2. This is the dark gray form that has two holes. We will use 5 turns of #26 magnet on the Low Pass filter side and 2 turns of #26 on the Q7 collector side. To wind five turns start on one end with a piece of the brown wire in your kit. Put the wire through one of the holes then bring it back through the other hole. This counts as one turn. Put the wire back through the hole again, and bring it back through the second hole. You should have 2 wires through each hole and the start and the end of the wire are on the same end of the form. Repeat this until you have 5 wires in each hole. This is the 5 turn side. Now, start at the opposite end of the form and wind 2 turns of wire with the second piece of insulated wire. This is the Primary. It should have 2 turns or wires in each hole, and the two primary wires should be outside the same end as shown in the drawing.



PA Transformer

Testing:

Press PTT, verify Q6 emitter voltage is 0.5 to 1 V, verify Q8 emitter voltage is 0.5 to 1 V. Adjust R45 for highest voltage on D12. Verify 12V collector voltage on Q6, Q8 and Q7(not installed yet)

Now confirm the transmitted 75M RF levels in PA chain. Close PTT, speak into mike, R46 should have 1/2 to 1 volt peak to peak of 75M RF. R99, a 20-ohm base resisitor should have 2 to 4 V peak to peak of 75M RF across it.

You'll need to peak the two transmit filter trimmer capacitors C3, C4 on the band module board. Adjust C3 and C4 for maxium RF level at R99. While speaking into the mic, verify the RF signal at R99 doesn't appear "clipped" on the scope.

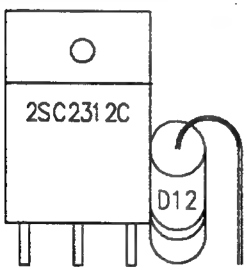
To listen to the Cascade transmitter audio use HEADPHONES on your station receiver while speaking into the Cascade mic. Tune in the transmitted signal on the station receiver. A dummy load on the Cascade isn't needed, the 2SC2312 isn't installed yet.

The transmitted audio should be free

of distortion, now adjust BFO capacitor for "best transmitted audio". This will take some time to get a feel for the right position After adjusting the BFO cap you'll need to retune the station receiver. Don't install Q7 until you're satisfied with the "clarity" of the Cascade transmitted audio heard in your station receiver. If you're using the Radio Shack speaker-mike try holding the mike about 3 inches from your mouth, holding it closer adds excessive wind noise. Write down your BFO frequencies for future reference.

SECTION 9: PA FINAL

Install the Q7 2SC2312. Position Q7 in contact with the bias temperature compensation diode D12. D12 needs to be in physical contact with the plastic case of Q7. **DON'T SOLDER YET!**



Place the 2SC2312 in the board, and make sure that it makes contact with D12 as shown above. Attach the back panel using the hardware for the BNC connector and the screw in the angle bracket. Carefully mark the position of the hole to mount the transistor on the back panel. Do this carefully, and try to be sure that the transistor is seated fully and making contact with the diode. After marking, remove the back panel, use a center punch to mark the spot for drilling, and drill a 1/8 inch hole in the back panel. Secure Q7 to the panel using a mica washer and 4-40 hardware. If you have heat sink compound, use it when securing Q7, apply some to D12 also. Attach the panel to the circuit board and try to avoid taking it off in the future.

Connect a 50 ohm, 10 watt dummy load to the antenna jack J5. Place a 2A ammeter in series with the 12V DC supply. Close the PTT, slowly decrease R45 while monitoring the J2 12V supply current. Adjust R41 so the idle supply current increases from 70mA to 250mA during TX. Do this with out speaking into the mic. Confirm the Voltage at D12 is approximately .7 volts.

Now repeat the same audio test in Section 8 above. Listen to the transmitted audio in your station receiver using headphones. The audio should be free of distortion as before. Confirm the J2 12V supply current peaks to 3/4 to 1 1/4 amp on voice peaks. Over-driving the NE602 first transmit mixer can cause distorted audio. To reduce the drive level, reduce the mike gain resistor R63 from 10K TO 4.7K.

Use a calibrated watt meter to verify the output power levels on both bands. Verify the peak RF levels at J5, the antenna jack, are 50 to 60 Volts peak-to-peak on 75M, 40 to 50 volts peak-to-peak on 20M. Five watts pep equates to 45V peak-to-peak into a resistive 50 Ohm load.

Now readjust the carrier balance R7. Un-plug the mike connector, close the PTT line with a clip lead. Null the 9MHz RF carrier seen at the antenna jack You should be able to reduce it to under 0.5V peak to peak.

If you use a battery for the 12V supply, make sure it doesn't drop below 11 Volts. It is a good idea to check this often.

SECTION 10: FINAL ASSEMBLY

We are ready for the final assembly of the Cascade into the Case. Attach the front panel, using the appropriate screws. The 3 screws for the tuning capacitor may have to be filed down. We were unable to obtain a supply of 3/16" long screws, so we supplied 1/4" instead. You will have to

file them so that they just fit through the capacitor, but don't touch the plates. You should have at least 1/16" clearance between the end of the screw and the front plate of the capacitor.. Put the nuts and washers on the controls, the 6-32 screw in the bracket, and you are finished with the panel. Now attach the pointer to the hub, and the hub to the shaft, being careful to insure that you get it adjusted correctly so that the pointer won't rub on the panel. Check the pots to make sure that the tabs have been broken off so the panel fits flush. It is important to get the nuts on the mic jack.

You should have the front and back panels both mounted. The next operation is to remove the tempory wire jumper between W1 and W2. Use solder wick. Cut a piece of the tiny coax cable to fit between W1 near the front panel and W1 next to the band module. You will install this on the bottom of the board. The coax is only grounded at one end, the one nearest the band module. **DO NOT GROUND** the end of the coax nearest the front of the board. The center conductor of the coax is connected at both ends, but the braid is only connected on the end closest to the band module.

Install W2 in the same manner as W1, remembering that the coax is only grounded nearest to the band module end.

Next mount the plastic latches on the bottom of the case. That is the one with the two mounting holes drilled in the bottom. Use the 2 flat head 1/4" 4-40 screws to mount the circuit board to the case bottom. All that is left is to put the catches on the top of the case, snap it on, and your Cascade is finished except for painting and labeling.

We are leaving the labeling of the Cascade up to you. That is what makes a home brew rig unique and it gives you the opportunity to "customize" your rig. We are not providing a screen service as we did for the NorCal 40 and the Sierra. It just became too big of a job, and it lasted far too long.

If you decide to paint your Cascade, **DO NOT** Paint the inside of the panels!! Also, each time that you remove the back panel, be sure to apply more heat conductive grease to the final.

CASCADE OPERATION NOTES

12V POWER REQUIREMENTS

You'll need a supply capable of 2 amps on voice peaks. It's a good idea to monitor both the 12V input current and voltage during your initial check out. When operating the rig with a battery select one with enough capacity. Lead acid batteries should be rated at 4A/hr and Nicad batteries should be rated at 2.2A/hr.

ANTENNA

Avoid transmitting into an unknown VSWR or over 3:1. The PA transistor isn't protected by high SWR shut down circuitry. An inline SWR/Pout wattmeter is recommended. It's best to do the initial rig check out into a dummy load. This insures an excellent SWR.

2 METER SPEAKER MICROPHONE

The rig accommodates a "Icom standard" speaker microphone. These microphones come in two sizes. The larger style will have better fidelity for SSB. The compact microphone style has a lot of distortion. Several prototype builders purchased the Radio Shack Microphone for $19.95. This gave adequate performance

Resist the natural temptation to shout or "close talk". The microphone amplifier chain has a sensitive speech processor. Holding the microphone about 3 inches from your mouth is about right. Soliciting on the air transmitted audio reports is the best way to know if everything is working as it should. If you have more the one microphone, see which one works best.

RF/AF GAIN

It's best to set the AF gain at a moderate level, RF gain fully clockwise. Lower the RF gain if extreme signal levels are present or the background noise level is to high.

INTERNAL ADJUSTMENTS

BFO

This is the critical one. It's a bit touchy to get right. The BFO trimmer sets the pitch range on the receiver and transmitted audio. Start by adjusting the 75m trimmer C90. Find a solid S9 signal on the 75m band, adjust until the the audio has enough highs and lows. You'll need to touch up the VFO as you move the BFO. As a final tweak, do an on the air transmitted audio test with a fellow ham. Try a small change and see if it is better or worse.

Another BFO alignment technique is to measure the 3dB passband. Here you'll adjust the BFO to set the 3dB points at 300Hz and 3000Hz. One can do this with only a DVM and station transmitter as a signal source. Use your station transmitter to radiate a steady S9 carrier into the Cascade receiver. Connect the DVM set to AC volts across the speaker terminals. Use the transmitter's incremental TX tuning to find the 3dB points in the pass band, 70% reduction in voltage. Adjust the BFO to get these at 300 and 3000Hz.

Carrier Balance

You'll need a QRP watt meter for this one. Set it to its lowest scale, 1W full-scale. Key the microphone, and without speaking adjust for minimum output.

PA Bias

Measure the voltage drop across R80. We'll want to set the voltage for Iceq = 250mA or 250mV from R80 to ground.

AGC Threshold

Set to mid-range of pot rotation. Find a " strong S9+ " station start turning the pot CCW. When the audio starts to drop, back off 1/4T.

1. DC Voltage Chart for Active Devices

Conditions: Receiving, no signal, 14.1V power supply, using a DVM.

Device	Pin	Voltage to Ground
U1	1	1.41
	2	1.41
	3	0
	4	5.59
	5	5.58
	6	6.68
	7	6.07
	8	6.75
U2	1	1.27
	2	1.27
	3	0
	4	5.97
	5	5.58
	6	6.68
	7	6.07
	8	6.91
U3	1	0
	2	3.64
	3	7.62
	4	1.75
	5	1.73
	6	0
	7	1.36
	8	1.36
U4	1	13.88
	2	0
	3	7.98
U5	1	1.42
	2	0.82
	3	0
	4	6.35
	5	13.86
U7	1	1.41
	2	1.41
	3	0

	4	5.52
	5	5.53
	6	6.66
	7	5.98
	8	6.72
U8	1	7.98
	2	7.98
	3	7.97
	4	0
	8	13.88
Q1	S	0
	G	0
	D	7.91
Q2	S	0
	G	0
	D	7.90
Q3	E	7.99
	B	7.98
	C	0
Q5	S	6.72
	G	13.84
	D	0
Q11	S	6.72
	G	13.92
	D	6.73
Q12	S	1.94
	G	0
	D	7.98
Q17	S	5.56
	G	3.42
	D	5.56

Conditions: Transmitting, no audio, 14.07V power supply, DVM.

U6	1	1.40
	2	1.40
	3	0
	4	5.06
	5	5.02
	6	6.16
	7	5.49
	8	6.21
Q6	E	0.53
	B	1.19
	C	13.0
Q7	E	0.084
	B	0.74
	C	13.66
Q8	E	1.08
	B	1.82
	C	13.67
Q10	E	0
	B	0.78
	C	0
Q13	S	1.73
	G	0
	D	7.41
Q14	S	0
	G	0
	D	7.40
Q15	S	0.92
	G	7.40
	D	0.92
Q16	S	0
	G	7.36
	D	0

2. Check BFO and LO Signal Sources:

Measure TX BFO injection level U2 pin 6:
175mV rms TX, PTT closed
Measure TX VFO injection level U6 pin 6: 175mV rms TX, PTT closed
Measure RX BFO injection level U1 pin 6: 175mV rms RX
Measure RX VFO injection level U7 pin 6: 175mV rms RX
Measure 20M BFO frequency:
8998.0KHz typical

Measure 75m BFO frequency:
9001.0KHz typical
Measure 20M VFO band limits:
5.15MHz to 5.35MHz
Measure 75M VFO band limits:
5.05MHz to 5.25MHz

3. Trace Receiver signal path with a 5mV rms signal at the antenna jack.

RX Mixer 1 output at U7 pin 4:
100mV rms
IF filter output at U1 pin 1:
50mV rms
RX Mixer 2 output at U1 pin 4:
6mV rms DMM only AC V
AF pre-amplifier output at U8 pin 1:
120mV DMM only AC V
AF power amplifier output at U5 pin 4:

AF output at speaker jack:

AGC voltage at Q17 gate:

4. Additional Reciver Checks

IF Bandwidth:
2900Hz at 6dB (1/2 voltage) points
RX DC current drain:
65mA

5. Trace Transmitter Signal Path

Press PTT switch and whistle into mike. Note: values measured Voltage peak to voltage peak, divide by 2.8 to compute RMS value.
Mic bias at J1 pin 2:
2 volts DC
Mic pre-amp output at Q12 source:
50mV
Mic amplifer outut at U3 pin 8:
400mV
TX Mixer 1 audio injection level at U2 pin 1:
150mV

Mic amplifier output

TX Mixer 2 output level at U6 pin 5:
300mV
TX amplifer output at Q13 source:
300mV
TX Spur Filter output level at Q6 base:
200mV
TX Buffer amplifier output at Q8 base:
1.5V
TX Drive amplifier output at Q7 base:
3.0V
TX PA output J4 pin 5:
45V
TX output at antenna jack:
40V

6. Additional Transmitter Checks

TX 12V current drain on voice peaks:
1.7A
TX 12V current drain PTT close, don't talk:
290mA

CASCADE OPTIONS:

17M / 40M Conversion

The first option describes circuit value changes to put the rig on 40 and 17 meters. This modification is complex, seek the help of an experienced member if you're unsure.

Several changes need to be made; VFO and BFO, IF crystal filter, Low pass filter, TX spur filter, and RX pre-selector filter. You will need two blank 20M bandmodule boards, or with some reworking, 2 blank Sierra band module boards.

I'd make sure the rig works as it should on 75/20 meters, then rework the rig to operate on 17/40M. This approach is a lot more time consuming but you'll know that everything else works before starting to change all the filters.

12.288MHz Crystal Filter

The IF crystal filter changes from a 9MHz to a 12.288MHz center frequency. You'll need to buy 10 to 12 crystals from Digikey. Next measure each crytal's series resonate resistance, and frequency shift values. G3UUR describes how all this is done in a recent (June, 1995 ARRL QEX) ar-

ticle titled "Refinements in Crystal Ladder Filter Design" by Wes Hayward

The filter article shows how to calculate the motional capacitance and Q values needed to design a filter. I used Wes Hayward's filter program to designed a Butterworth SSB filter using the following crystal parameters. Confirm your measured crystal nominal parameters are similar.

Case HC49/U ONLY
F-series = 12.288MHz
R-series = 15 ohms
L-motional = 0.0063H
Cp = 5pF
Q = 31,000

Select 5 crystals from your batch of 10 crystals that match within 150Hz. The 12.288 MHz filter's 3dB Bandwidth is 2700Hz and the R-termination 750 ohms. Component value changes:

Y2-Y6 HC49 12.288MHz crystals
C77, C81 47pF 5% silver mica
C79 39pF 5% silver mica
C78 C80 68pF 5% silver mica
C82,C83 120pF 5% silver mica
Cin Cout 10pF 5% ceramic
(Add Cin and Cout to input and output of filter, shunts to ground)

TX Low Pass Filters
Use 20M bandmodule board

	40M	17M
C12,C16	390pF 200V cer.	180pF 5%
C15	820pF 200V cer.	330pF 5%
L2, L3	T37-2 18T 1.36uH	T37-6 14T 0.57uH

RX Pre-selector Filter
Use 20M bandmodule board

	40M	17M
L1	FT37-61 16T 14uH	T37-6 24T 1.7uH
T1	FT37-61 16T 14uH Primary 1T	T37-6 24T 1.7uH Primary 2T

TX Spur Filter
Use 20M bandmodule board

	40M	17M
L4,L5	T37-2 16T 1.02uH	T37-2 16T 1.02uH
C3,C11	330pF	180pF 5% ceramic
C4,C10	100pF	22pF 5% ceramic
C7	22pF	2.5pF (two 5pF in series) 5% ceramic
C5, C9	330pF	22pF 5% ceramic
Bandwidth:	400KHz	800KHz
R-terminations:	50 ohms	50 ohms

BFO
Y1 change to 12.288MHz Crystal

5MHz VFO

To tune the 40M phone segment with a 12.288MHz IF, the VFO needs to shift down slightly. For the 17M phone segment, the VFO needs to shift up 850kHz. Since the 17M phone subband is only 58kHz wide the tuning range is also reduced from 200kHz to 60kHz.

40M VFO
4.988MHz to 5.138MHz
J4 pins 25 to 23 SHORTED

17M VFO
5.822MHz to 5.880MHz
J4 pins 25 to 23 OPEN
L1 No change 5.1uH 33T total T50-7 Tap at 8T

C22 now 47pF ceramic NP0
C34 add 220pF ceramic NP0 in parallel
C89 not used short with wire
Connect J4 pin 23 ground return to junction of C22 and C25 NOT to ground. This pad is just to the left of trimmer C34, cut away ground and reconnect.

VFO Aligment:

1. If possible measure L1, should be 5.1uH
2. Install 40M bandmodule board with J4 25 to 23 shorted
3. Set C18 to Fully meshed position
4. Measure VFO frequency using station reciever, should be around 4.988MHz. Write down the frequency.
5. Remove 40M band module board
6. Subtract 850kHz from frequency in step 4. Adjust C34 so the VFO now oscillates at the new higher frequency.
7. Reinstall the 40M band module board. Adjust C17 to reach 4.988MHz. Add additional shunt C to C17 to reach 4.988MHz if frequency is too high. Start with a small amount, i.e. 10pF NP0.
8. Check tuning range on 40M is at least 200kHz, Check tuning range on 17M is at least 60kHz.

Cascade Parts List

C1, 16, 24, 37, 42, 43, 49, 50, 51, 52, 55, 56, 57, 58, 59, 60, 62, 74, 75, 84, 88, 92, 95, 100	0.1uF
C2, 4	47pF
C3, 9, 11, 12, 13, 32, 33, 40, 47, 67, 87	2.2/25V Elect/Tant
C5, 7, 8, 53, 63, 68, 69, 70, 71, 91	.047uF
C6	220pF
C10	1000pF
C14, 15, 65, 66, 86	22/25V Elect.
C17	2-12pF Air Trimmer
C34	2-20pF Air Trimmer

Note: Mouser 530-189-0509-5 will sub for C17 & C34

C18	5-40pF/w 8:1 Drive
C19	2-12 Trimcap
C20, 76	5pF NPO
C21	82pF NPO
C22	270pF NPO
C23	47pF NPO
C25	100pF NPO
C26	10pF
C27, 31, 35, 39	100uF/25V Elect.
C29, 30, 72, 73	470pF
C38, 44, 94	.47uF
C99	10uF/25V Elect.
C41	.22uF
C46	.01uF
C47	2.2uF Non Polarized
C64	.001uF
C77, 81	150pF SM
C78, 80	47pF SM
C79	56pF SM
C85	.02uF
C89	Wire Jump
C90	4-20pF Trimcap
C96	1uF Non Polarized
C97	.002uF
C99	10uF/25V
D1, 2, 5, 6, 7, 8, 10	1N914
D3	1N5819
D4	100 ohm resistor
D12	1N4001
J1	2.5mm Mono Jack
J2	2.1MM DC Jack
J3	3.5mm Stereo Jack
J5	BNC JACK
L1	5.1uH - T50-7 33T - Tap 8T
L2	33uH - RFC

L3	15uH - RFC
L4	56uH - FT37-43 15T
L5	56uH - FT37-43 15T
L33	15uH - RFC
Q1,2	2N4416A
Q3	2N3906
Q5, 11, 15, 16	2N7000
Q6	2N2222A
Q7	2SC2312C
Q8	2N3866
Q10	2N4124
Q12 , 13	J310
Q14	J176
Q17	2N5484
R1, 14, 15	1M
R2, 11, 59, 73, 97, 98	10K
R3, 9, 10, 47, 48	470
R4, 13, 36, 39, 63, 72	1K
R5, 6, 20, 56, 65, 68, 69	47K
R7	1K Trimpot
R8	Open
R12, 17, 31,38	47
R16, 97	100
R18, 19, 21, 35, 54, 60	4.7K
61, 70	4.7K
R22, 26, 57, 62	2.2K
R24, 55	4.7M
R25	2.2
R27	1K Pot
R28	200
R32	39
R33	4.7
R34, 44	560
R40	150 - 1Watt
R41	180
R42, 99	20
R45	500 TRIM
R46, 51	390
R49	1K POT
R50	1.8K
R52	1.5K
R58	Open
R64	10K TRIM POT
R67	1.1
R80, 81	1.0
S2	SPST
T1, 3, 4, 5, 6	27uH 8T Bifilar FT37-43
T2	B43-201 2T Pri 5T Sec
U1. 2, 6, 7	NE602AN
U3	SL6270
U4	UA78L08C
U5	LM383, UPC2002
U8	NE5532
Y1, 2, 3, 4, 5, 6	9.000 Crystal Matched to 100 Hz.

20 Meter Band Module

C1, 2, 6, 8	9-50 pF Trimmer
C3, 11, 15	470pF
C10, 4	47pF
C5, 9	82pF
C7	5pF
C12, 16	220pF
L1	2.9uH 31T T37-6
L2, 3	.58uH 12T T37-2
L4, 5	.78uH 14T T37-2
T1	2.9uH 31T/3T T37-6

75 Meter Band Module

C1, 2, 8, 6	9-50pF Trimmer
C3, 11,	1800pF
C15	1200pF
C5, 9	220pF
C7	2700pF
C12	680pF
C13, 14	150pF
C16	560pF
L1	50uH 30T FT37-61
L2	2.1uH 23T T37-2
L4, 5	7.96uH 12T FT37-61
T1	50uH 30T/2T FT37-61

DESIGNER'S NOTES:

I'd like to thank the many NorCal members that made this kit possible, and especially you who bought the kit solely on NorCal's excellent reputation.

Jim Cates, finance manager, who oversaw that NorCal standards were met.

Doug Hendricks, QRPp editor, who prepared over 200 Cascade parts kits, edited text, schematics, charts and drawings into an outstanding kit manual, acquired and sorted over 64,000 high quality parts (many purchased at unheard of savings) for

NorCal members. Doug has been a joy to work with during the past 10 months. His endless enthusiasm for QRP keeps us all going.

Prototype kit builders; Dave Meacham, Doug Hendricks, Vern Wright. and John Koenig. Dave was a key technical contributor and helped refine the design.

Jeanette Hayes and Terry Sherbeck for PCB design assistance.

Early design consultants; the entire BC (SSB) QRP gang, Derry Spittle, Bruce Gellatly, and Joe Stipek. Wayne Burdick, Wes Hayward, and Roy Lewallyn.

I hope you enjoy the challenge of building a SSB transceiver. NorCal has a lot of members to team up with to build and test the Cascade. Contact Doug Hendricks, KI6DS, Dave Meacham, W6EMD, or myself, K7RO, we'll be thrilled to assist you.

I have great hopes for the Cascade, I think it ties into one of the major interests in ham radio - TALKING! Now, chatting with friends can be done on a rig you built yourself. I suspect most of you will want to add to the basic Cascade design. I encourage you to let Doug or I know what you've accomplished. Who will be the first to add CW? Who will add a digital display?

72, John

Moxon Rectangles for 40-10 Meters

by L.B. Cebik, W4RNL
1434 High Mesa Drive
Knoxville, TN 37938
email: cebik@utkvx.utk.edu

Since a postin on QRP-L, the Moxon rectangle has drawn considerable attention. A full analysis of the antenna appears in the Spring, 1995, issue of *Communications Quarterly*.

Basically, the Moxon rectangle is a wire antenna that can be fix-mounted or rotated. It is directional with about the gain of a 2 element Yagi (6 dBi in free space) and has an outstanding front-to-back ratio (greater than 40 dB in free space), with a very broad frontal lobe (-3 dB beamwidth = 70 degrees, usable beamwidth = nearly 180 degrees forward). The basic outline of the antenna appears in Figure 1.

Since the article and the posting appeared, I have heard of successful constructions of Moxon's, one for a Field Day Novice station. I have also had two types of requests. One has asked for dimensions for other bands. The other inquiry wondered if the feedpoint impedance might be brought closer to 50 ohms. The original design showed a feedpoint impedance close to 80 ohms.

I remodeled the antenna with good results on both counts. Table 1 provides dimensions for the Moxon rectangle for 40 through 10 meters. The dimensions are not perfect simple scalings, because the length-to-wire-diameter ratio changes for each ham band.

All of the antennas exhibit feedpoint impedances between about 56 and 58 ohms, a close match to the standard amateur 50 ohm coaxial cable. Free space gain and front-to-back ratio are consistent for all the models, averaging 5.8 dBi and greater than 32 dB in free space, respectively. Figure 2 shows a typical free space azimuth pattern for the antenna.

All of the models use #14 copper wire, although the various factors that contribute to the Moxon pattern tend to cancel out as wire size increases. Hence, a tubing model will have dimensions close to those for a thin wire model. However, it will exhibit a broader SWR bandwidth. The models were constructed on EZNEC, a NEC-2 implementation by W7EL.

At heights below 1/2 wavelength, the front-to-back ratio will deteriorate somewhat, but usable values can be obtained. Figure 3 shows the azimuth pattern of a Moxon Rectangle at the elevation of maxi-

mum radiation, with a height of a half wavelength above real, medium ground. The bandwidth for 2:1 SWR is only about 100 kHz on 40 with #14 wire. Above 40, the 2:1 SWR bandwidth covers the entire amateur band. For 30 and up, the front-to-back ratio is better than 15 dB across the band.

The original article showed one construction technique for 10 meters. Many others are possible, whether the material is wire or aluminum tubing. I shall leave the exact methods to the reader's ingenuity.

The standard of comparison for the Moxon is the 2-element Yagi. While a Yagi has marginally more gain, the Moxon's front-to-back ratio is very much superior. It will likely improve your ears much more than it will diminish your voice. And, as the old but true saying goes, if you can't hear 'em, you can't work 'em.

Moxon Dimensions for 40 - 10 Meters
Dimensions in Feet

Band	Freq.(MHz)	A	B	C	D	E
10	28.50	12.44	1.94	0.41	2.41	4.76
12	24.94	14.22	2.22	0.46	2.76	5.44
15	21.20	16.72	2.63	0.52	3.25	6.40
17	18.12	19.56	3.10	0.59	3.80	7.49
20	14.17	25.00	4.00	0.72	4.85	9.57
30	10.12	35.00	5.60	1.00	6.80	13.40
40	7.15	49.56	8.01	1.33	9.63	18.97

Note: All models composed of #14 copper wire.

Table 1

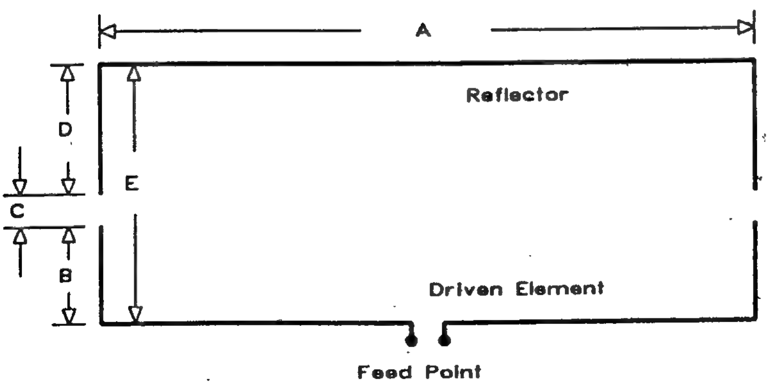
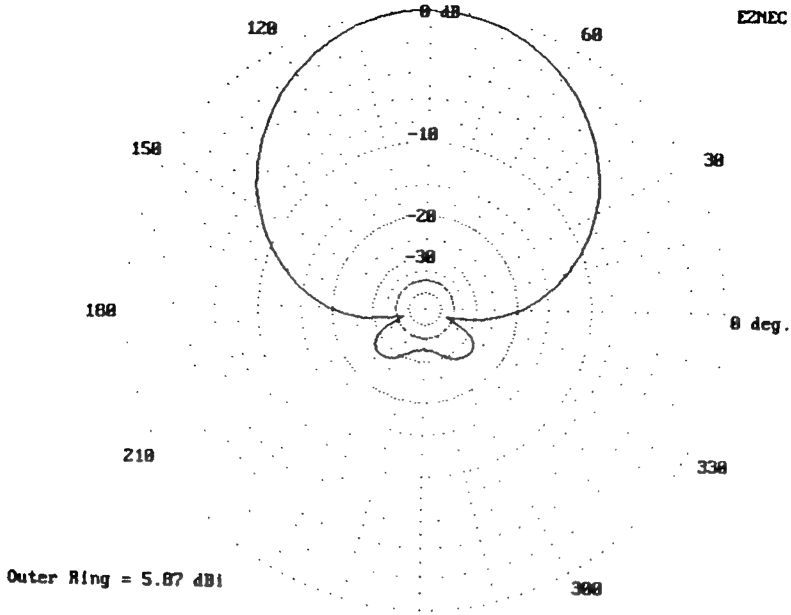
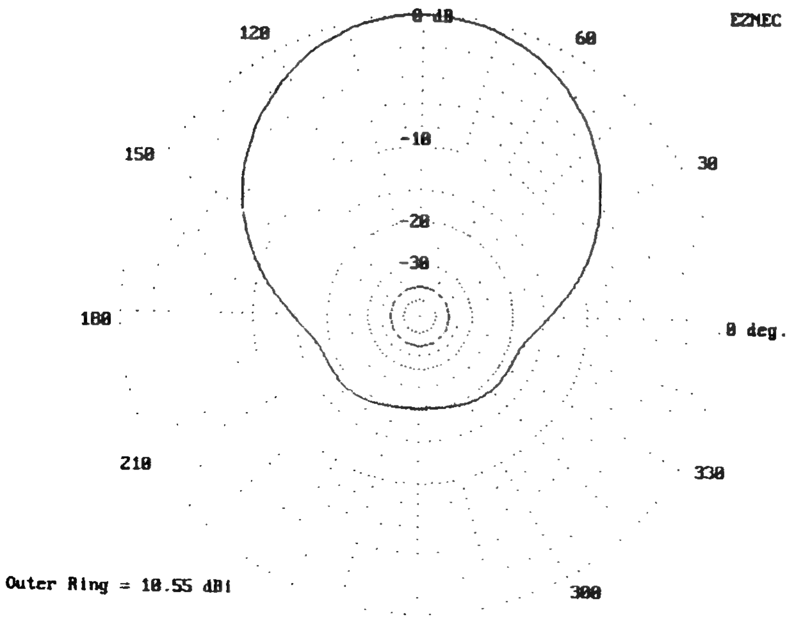


Fig. 1



0 dB
EZNEC
120
60
150
-10
30
-20
-30
180
0 deg.
210
330
Outer Ring = 5.87 dBi
300

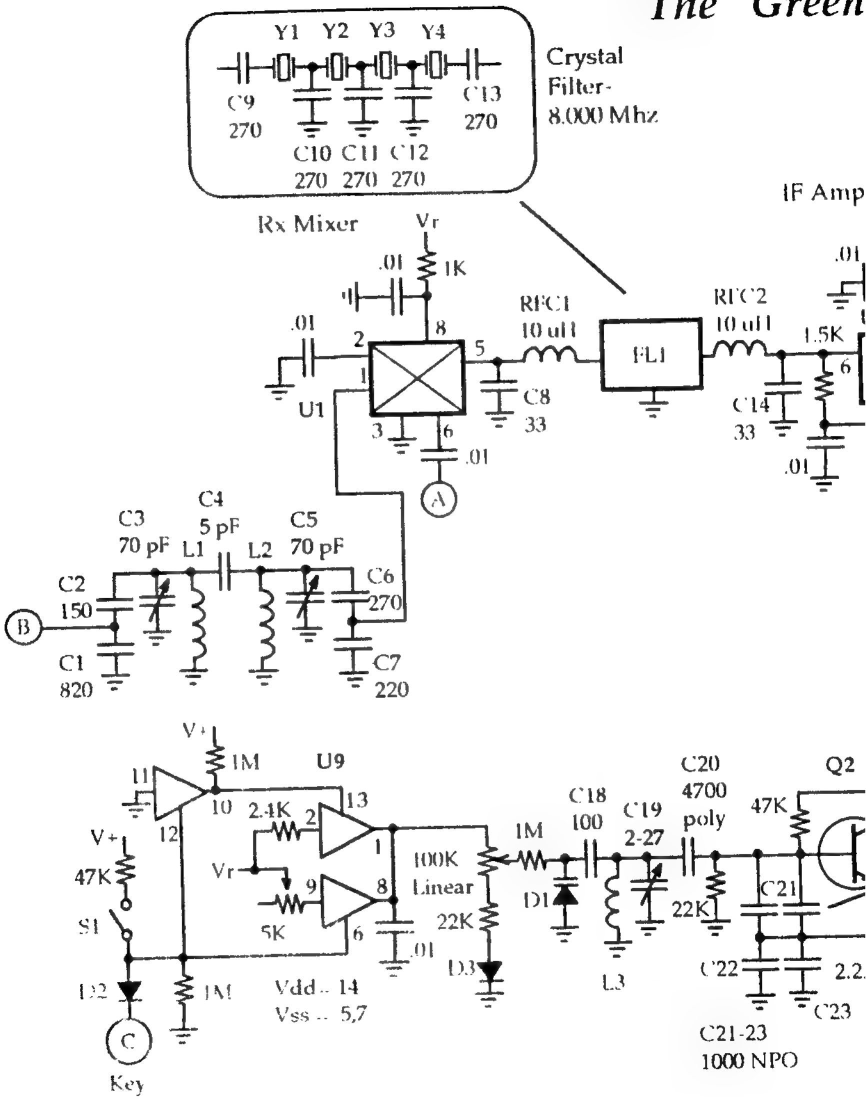
Fig. 2



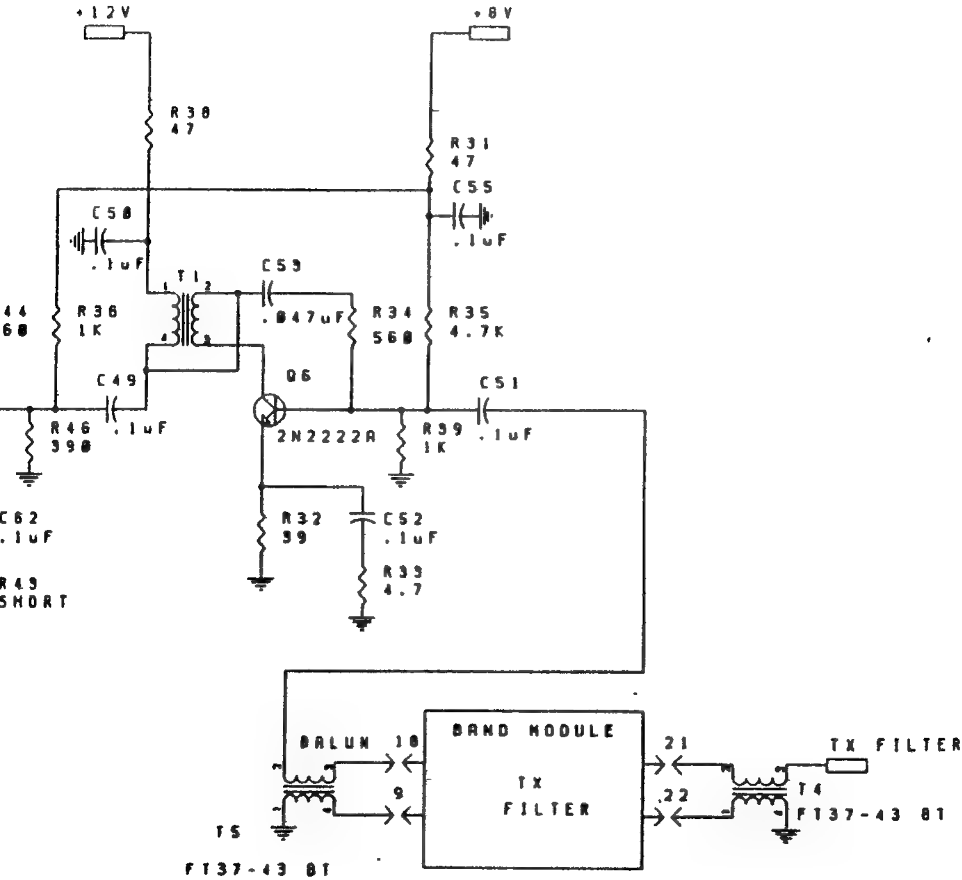
0 dB
EZNEC
120
60
150
-10
30
-20
-30
180
0 deg.
210
330
Outer Ring = 10.55 dBi
300

Fig. 3

The "Green

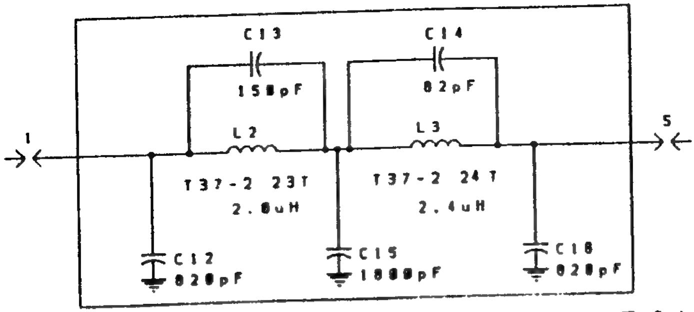

Y1 Y2 Y3 Y4
C9
270
C13
270
C10 C11 C12
270 270 270
Crystal
Filter-
8.000 Mhz
IF Amp
Rx Mixer
Vr
.01
1K
.01
2
8
5
1
U1
3
6
.01
A
RFC1
10 uH
FL1
RFC2
10 uH
1.5K
6
C8
33
C14
33
.01
.01
C4
5 pF
C3
70 pF
L1
L2
C5
70 pF
C2
150
B
C1
820
C6
270
C7
220
V+
1M
U9
11
10
12
13
2.4K
2
1
Vr
9
8
5K
6
.01
V+
47K
S1
D2
1M
C
Key
Vdd .. 14
Vss .. 5,7
100K
Linear
22K
D3
1M
C18
100
D1
C19
2-27
L3
C20
4700
poly
22K
Q2
47K
C21
C22
C23
2.2
C21-23
1000 NPO

POWER AMPLIFIER

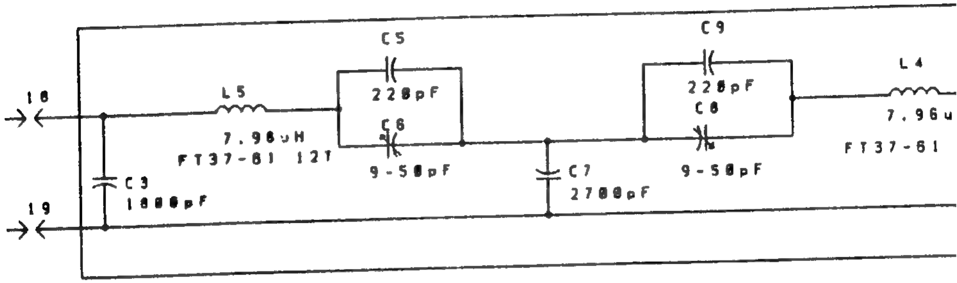


75m BAND MODULE

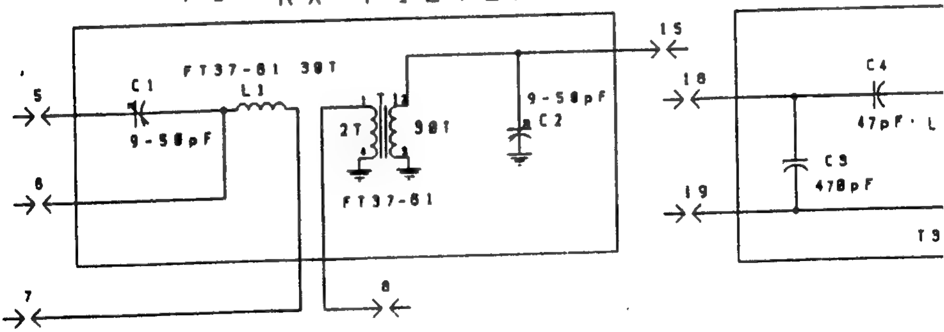
75m LOW PASS



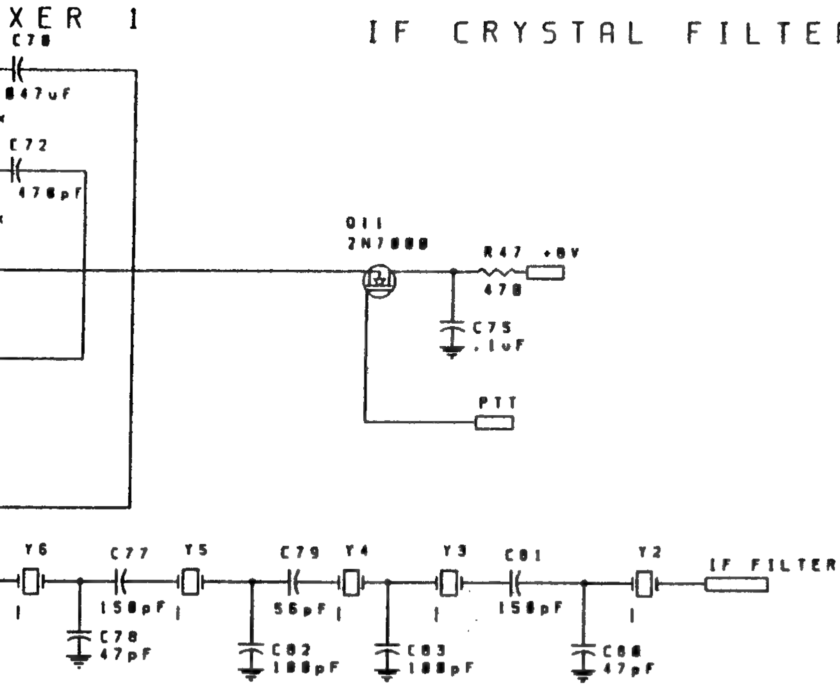
75m TX FILTER



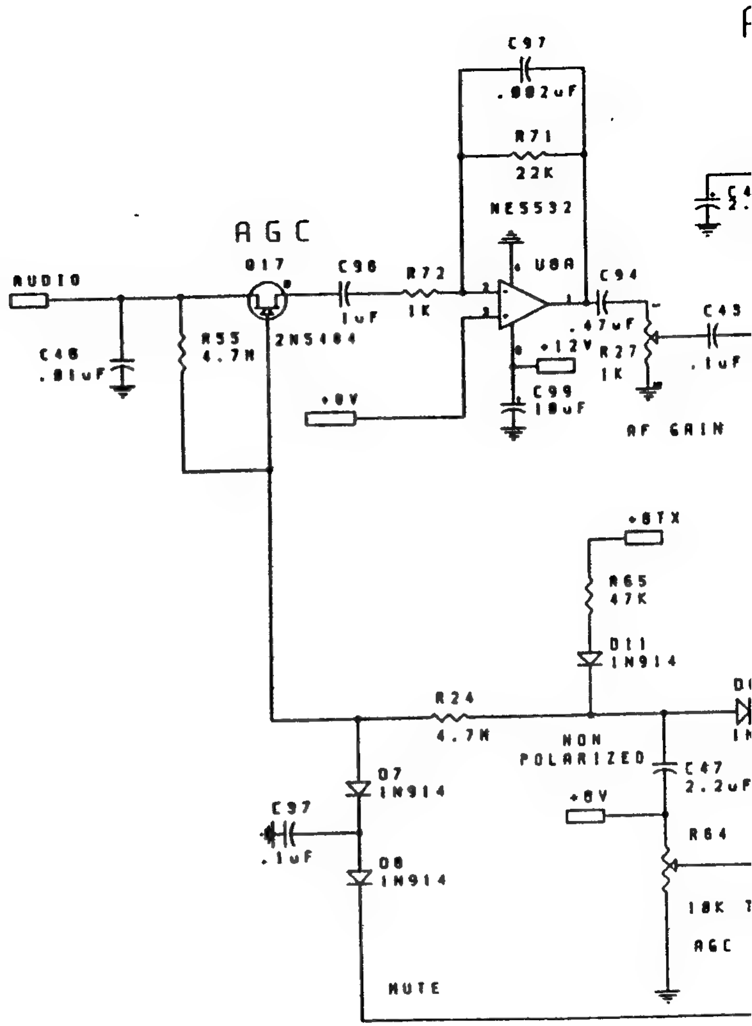
75m RX FILTER



IF CRYSTAL FILTER

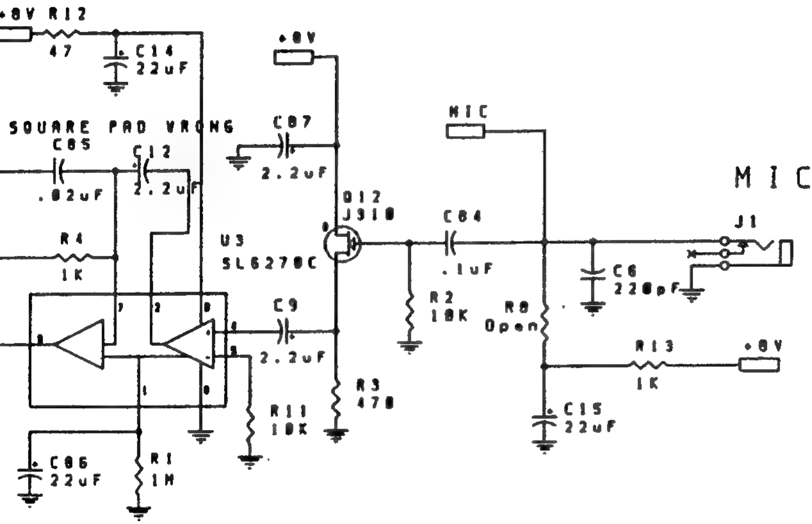


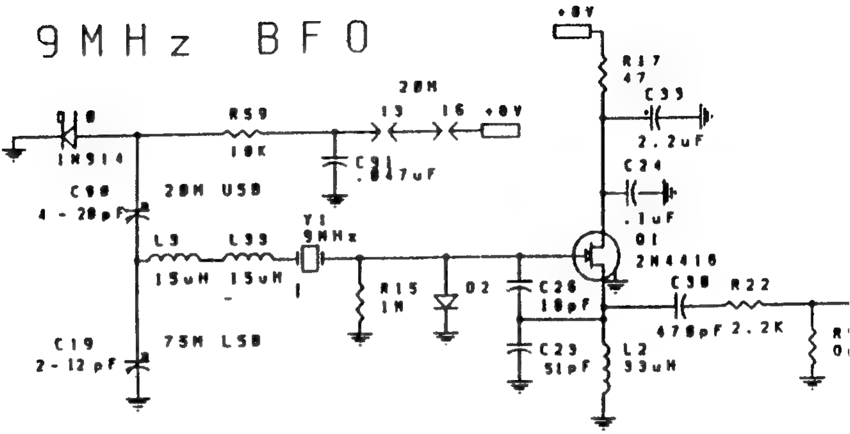
9.0MHz IF Filter
2.7KHz Bandwidth

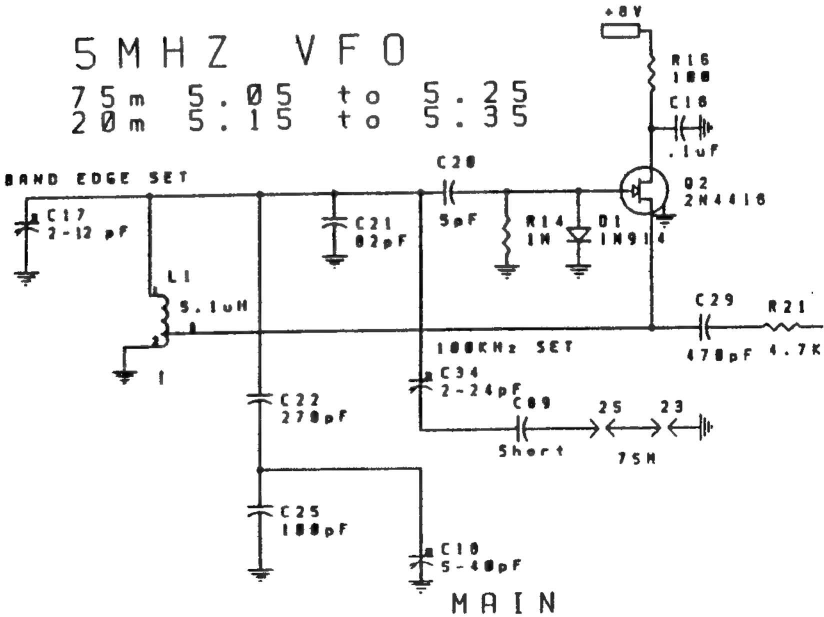

AGC
AUDIO
C48
.01uF
Q17
2N5484
R55
4.7M
C98
1uF
R72
1K
C97
.002uF
R71
22K
NE5532
U8A
+12V
C99
10uF
+8V
C94
.47uF
R27
1K
AF GAIN
C43
.1uF
+8TX
R65
47K
D11
1N914
R24
4.7M
NON
POLARIZED
C47
2.2uF
+8V
R64
10K
AGC
D7
1N914
C97
.1uF
D8
1N914
MUTE

PRODUCT DETECTOR

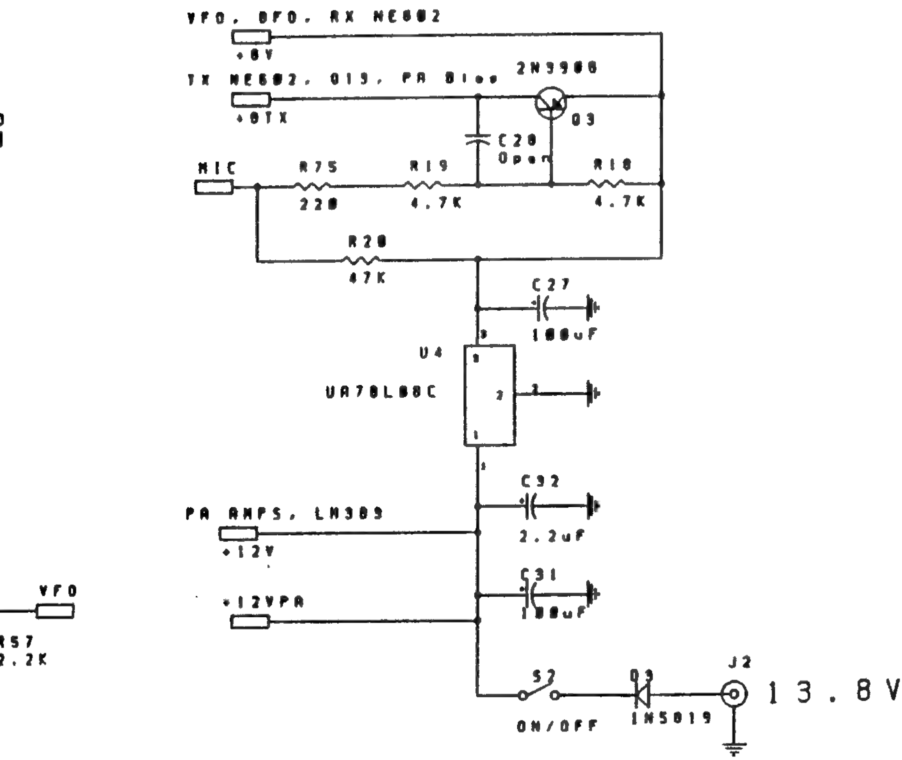
GAIN CONTROLLED MIC AMP



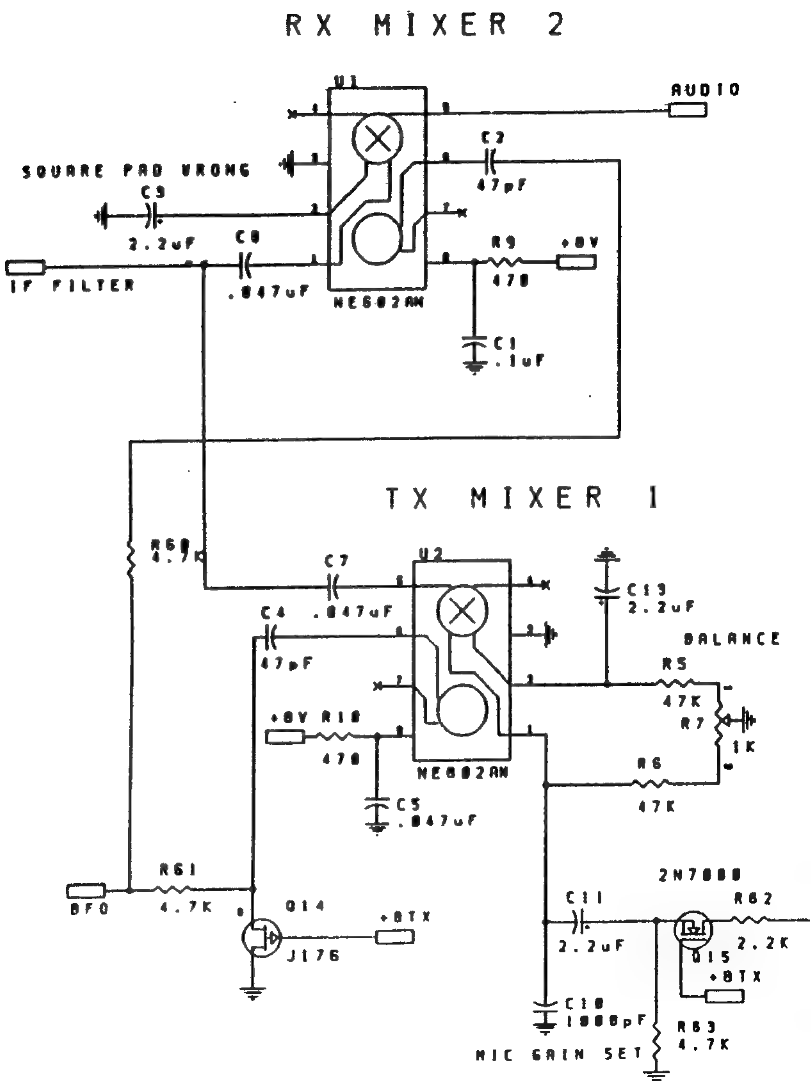

9MHz BFO
+8V
R17
47
C33
2.2uF
C24
.1uF
Q1
2N4416
20M
13
16
+8V
D10
1N914
R59
10K
C91
.047uF
C90
4-20pF
20M USB
L9
15uH
L33
15uH
Y1
9MHz
R15
1M
D2
C26
10pF
C23
51pF
L2
33uH
C30
470pF
R22
2.2K
C19
2-12pF
75M LSB


5MHZ VFO
75m 5.05 to 5.25
20m 5.15 to 5.35
+8V
R16
100
C16
.1uF
Q2
2N4416
BAND EDGE SET
C17
2-12 pF
C20
5pF
C21
82pF
R14
1M
D1
1N914
L1
5.1uH
C29
470pF
R21
4.7K
100KHz SET
C34
2-24pF
C89
Short
25
23
75M
C22
270pF
C25
100pF
C10
5-40pF
MAIN

V F O , B F O

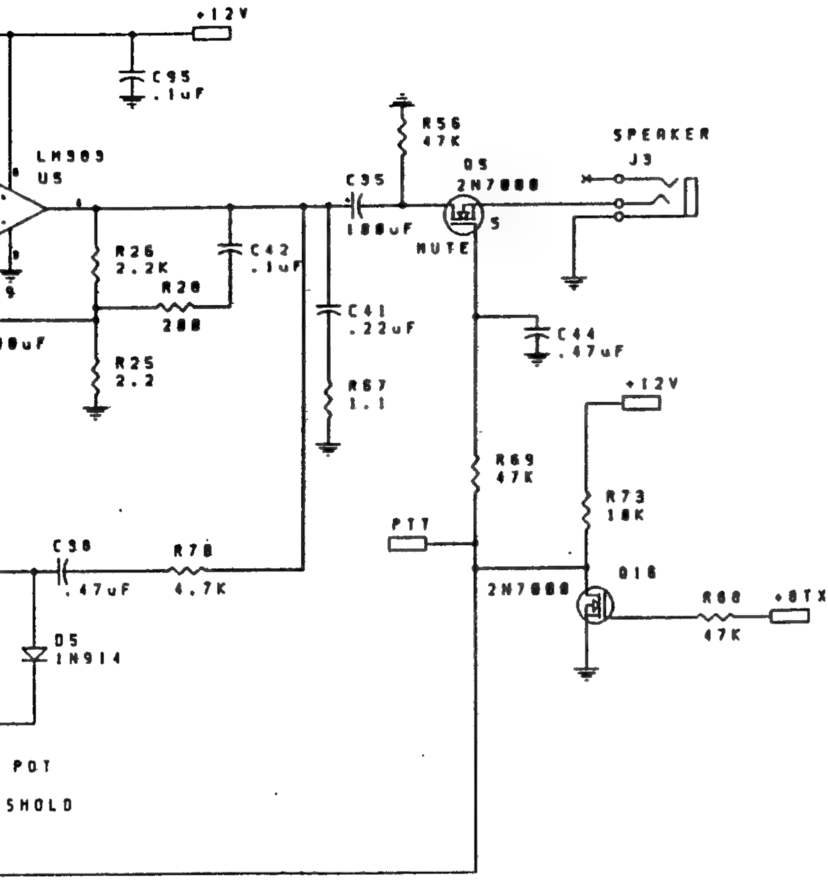


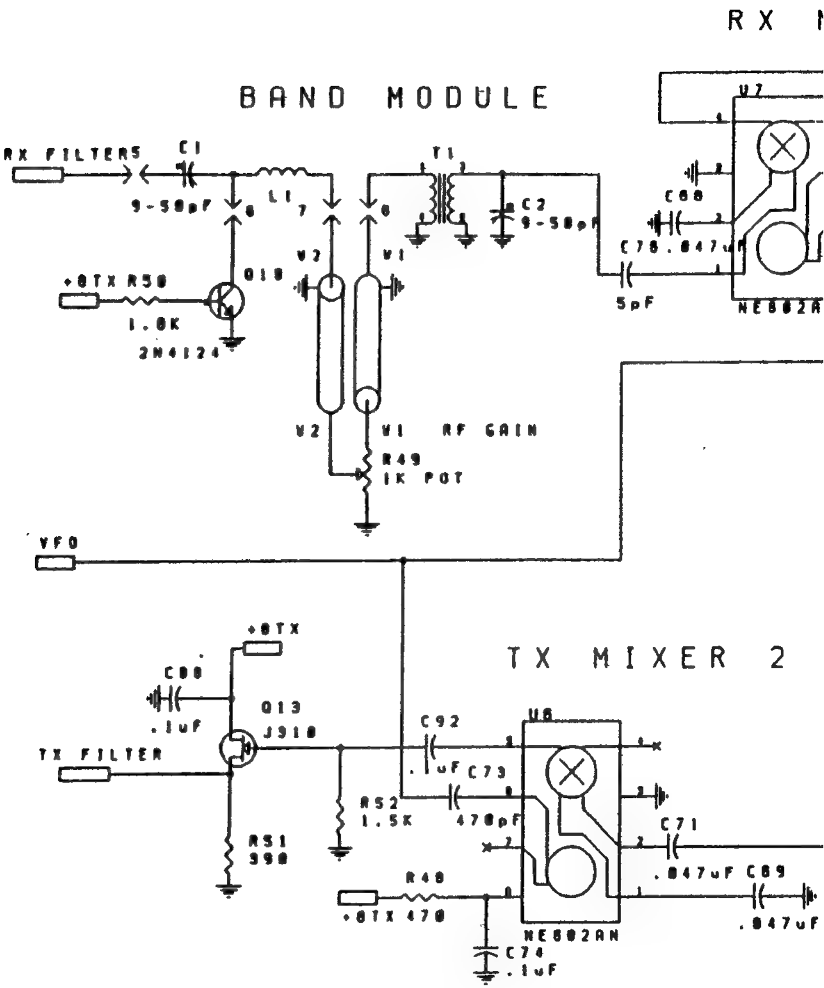
VFO, BFO, RX NE602
+8V
TX NE602, Q13, PA Bias
+8TX
2N3906
Q3
C28
Open
MIC
R75
220
R19
4.7K
R18
4.7K
R20
47K
C27
100uF
U4
UA78L08C
C32
2.2uF
PA AMPS, LM386
+12V
C31
100uF
+12VPA
S2
ON/OFF
D3
1N5819
J2
13.8V
VFO
R57
2.2K



RX MIXER 2
U1
AUDIO
C2
47pF
SQUARE PAD WRONG
C3
2.2uF
C8
R9
+8V
IF FILTER
.047uF
NE602AN
470
C1
.1uF
TX MIXER 1
R60
4.7K
C7
U2
C13
2.2uF
C4
.047uF
BALANCE
47pF
R5
47K
+8V R10
R7
1K
470
NE602AN
R6
C5
.047uF
47K
R61
2N7000
BFO
4.7K
Q14
+8TX
C11
R62
2.2uF
2.2K
J176
Q15
+8TX
C10
1000pF
R63
4.7K
MIC GAIN SET

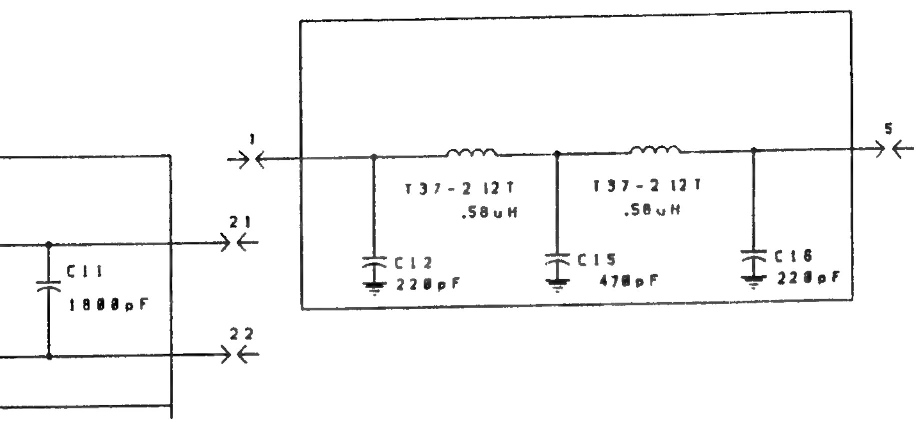
UDIO AMPLIFIER



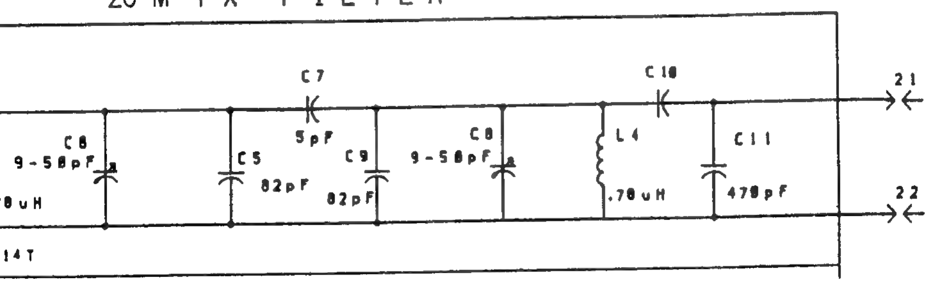

RX M
BAND MODULE
RX FILTERS
C1
9-50pF
L1
T1
C2
9-50pF
V2
V1
+8TX R50
1.8K
Q10
2N4124
U7
C68
C70 .047uF
5pF
NE602A
V2
V1
RF GAIN
R49
1K POT
VFO
+8TX
C88
.1uF
Q13
J310
TX FILTER
TX MIXER 2
C92
.1uF
U6
C73
470pF
R52
1.5K
R51
390
C71
.047uF
C69
.047uF
R48
+8TX 470
NE602AN
C74
.1uF

20M BAND MODULE

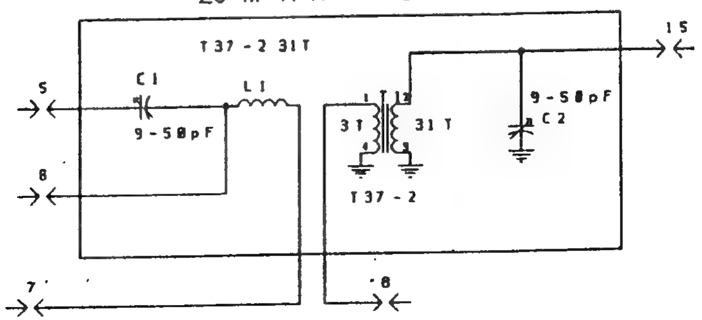
20M LOW PASS

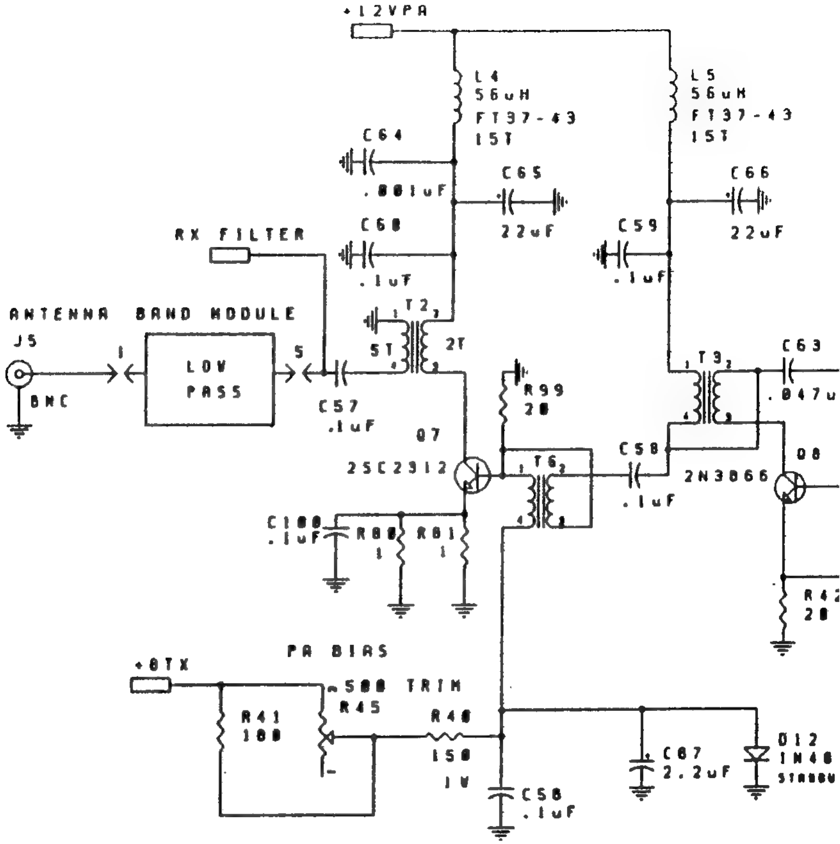


20M TX FILTER

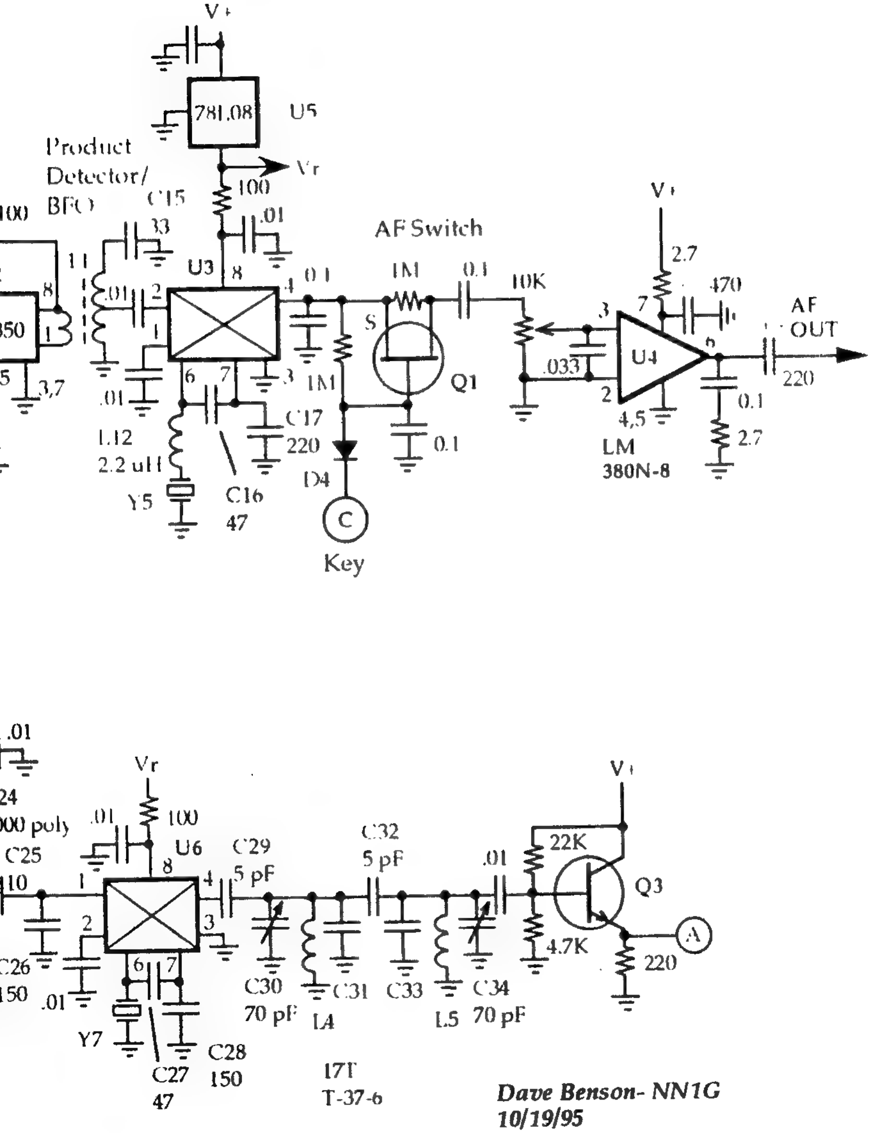


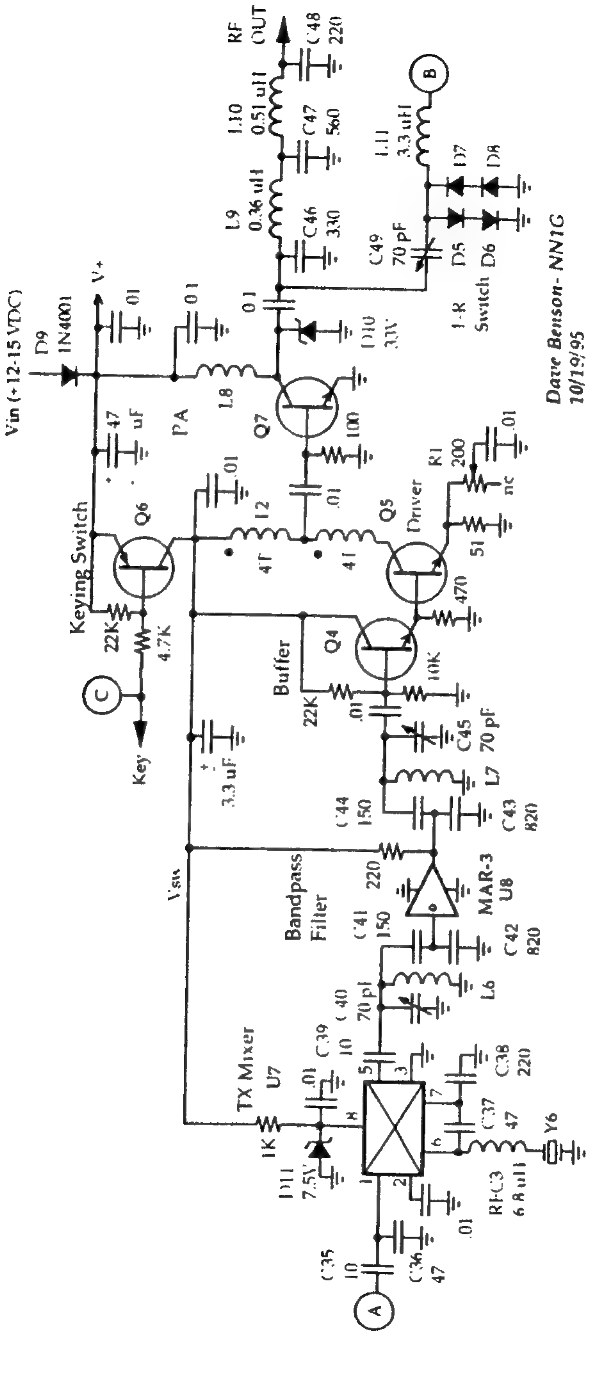
20M RX FILTER



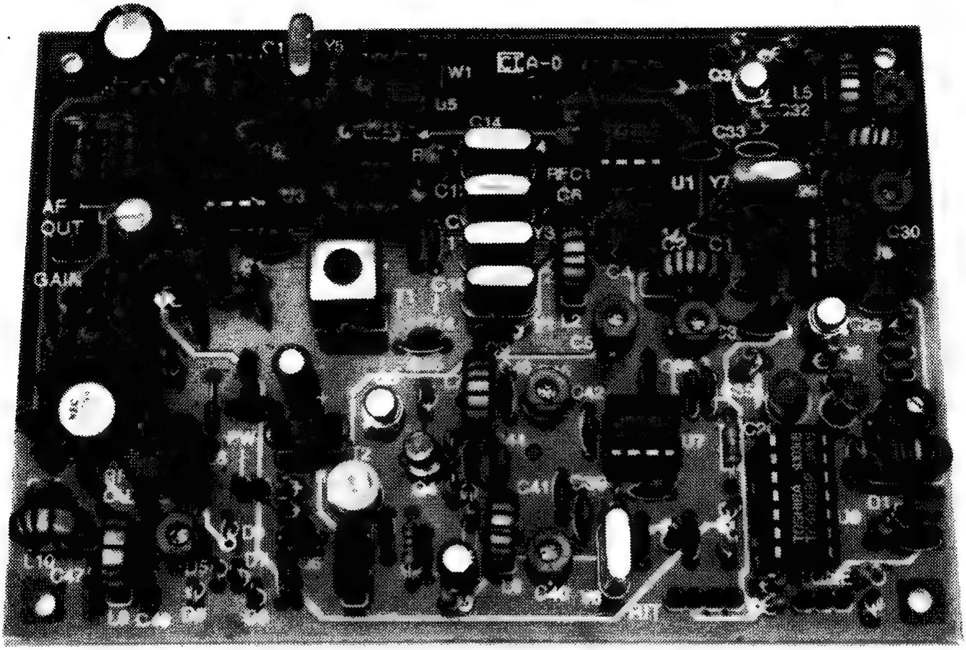

+12VPA
L4
56uH
FT37-43
15T
L5
56uH
FT37-43
15T
C64
.001uF
C65
22uF
C66
22uF
RX FILTER
C60
.1uF
C59
.1uF
ANTENNA BAND MODULE
J5
BNC
LOW
PASS
T2
5T
2T
C57
.1uF
Q7
2SC2312
R99
20
T6
T3
C58
.1uF
C63
Q8
2N3866
C100
.1uF
R80
1
R81
1
PA BIAS
+8TX
500 TRIM
R45
R41
100
R40
150
1W
C58
.1uF
C67
2.2uF
D12

ountain-20" Transceiver





Vin (+12-15 VDC)
D9
1N4001
V+
Keying Switch
Q6
22K
4.7K
C
Key
PA
L8
Q7
D10
33V
RF
OUT
L9
0.36 uH
L10
0.51 uH
C46
330
C47
560
C48
220
L11
3.3 uH
B
D7
D8
C49
70 pF
D5
D6
T-R
Switch
Dave Benson - NN1G
10/19/95
Q5
Driver
R1
200
51
470
Q4
Buffer
22K
10K
C45
70 pF
L7
C44
150
C43
820
3.3 uF
Vsw
220
MAR-3
U8
Bandpass
Filter
C41
150
C42
820
L6
C40
70 pF
C39
10
C38
220
C37
47
Y6
TX Mixer
U7
1K
D11
7.5V
RFC3
6.8 uH
C35
10
C36
47
A



Green Mountain CW Transceiver by Dave Benson, NN1G

Dave Benson, NN1G has designed a whole series of CW transceivers for the QRP CW enthusiast. Pictured above is the circuit board layout of his latest design. Dave's first design was the NN1G for 20 meters that appeared in the January 93 issue of QRP Quarterly, published by the ARCI. That radio was later kitted by Danny Stevig of Dan's Small Parts, and boards were made available from Far Circuits. The transceiver was on two boards, and was very popular as it was one of the first superhet transceivers to be made available at a cheap price.

The next rig that appeared in the Benson series was the New England 40-40, which was a club project for the New England QRP Club, and the idea of a club transceiver was modeled after the success of the NorCal 40. The name 40-40 came from the fact that it was a 40 meter rig and the cost was $40. You could also order a 30 meter version, called the 30-40. The New England Club only did 100 of the kits, but the demand was so huge that Dave started his own company, Small Wonder Labs to produce the 40-40 and 30-40 kits. He wrote an article for QST that caused his orders to go through the roof. He later added an RIT kit and a case and knobs package to the basic kit.

The 40-40 had a 2 pole crystal filter, no RIT or AGC in the basic unit. Dave was deluged with requests for another design incorporating these features and an improved crystal filter. He has done so, and the Green Mountain Transceiver is the result. All of the parts are extremely high quality, and the board is as good as they come. I especially like the idea of using the molex style plugs for the control connections. It makes the board much easier to troubleshoot. I first saw this in the Epiphyte I designed by Derry Spittle, VE7QK, and think that it is an idea that is well worth using. Ordering information for the Green Mountain Transceiver is page 65.

The Sierra - A Learning Tool

by John Pratt, N1UA
30 Nokomis Dr.
Trumbull, CT 06611

Numerous people have stated that they made modifications to their QRP rigs to improve and/or optimize performance along with advancing their understanding of the operation of the various circuits. I had a need to improve the 30 meter output power whcih was 1.2 Watts vs. 2.3 Watts for the 40 and 20 meter bands. Also, I wanted to see what kind of general power output improvements could be made, if any , without making major modifications to the Sierra circuitry. I have Jim Pepper's (W6QIF) DC Transceiver which puts out a good 4 plus watts. I seem to get more QRP contacts with this rig than I do with other 1-2 watt rigs. Jim says that it could be partly psychological and partly band conditions. I tend to agree with him but I will go with what works best for me - Hi. THis naturally led me to want to improve on the 2 watt average power I now get from the Sierra bands that I have. My bands of interest are the 40/30/20 meter bands. Being a life-long experimenter I wanted to try the suggestions made by others in QRPp. However, I also wanted to understand the "why" along with the "how". After all, once you're hooked on QRP building, then there is no turning back. My order is in for the NorCal QRP SSB rig, the Cascade.

The circuitry that I focussed on was the Sierra Driver and Power Amplifier/Output Filter. This consistent with work performed by other club members. The transmitter driver and power amplifier schematic is reproduced in Fig. 1.

The initial Sierra 40/30/20 meter driver and PA/output filter operating conditions for a Vcc = 12 Vdc are given in Table 1.

Figure 1

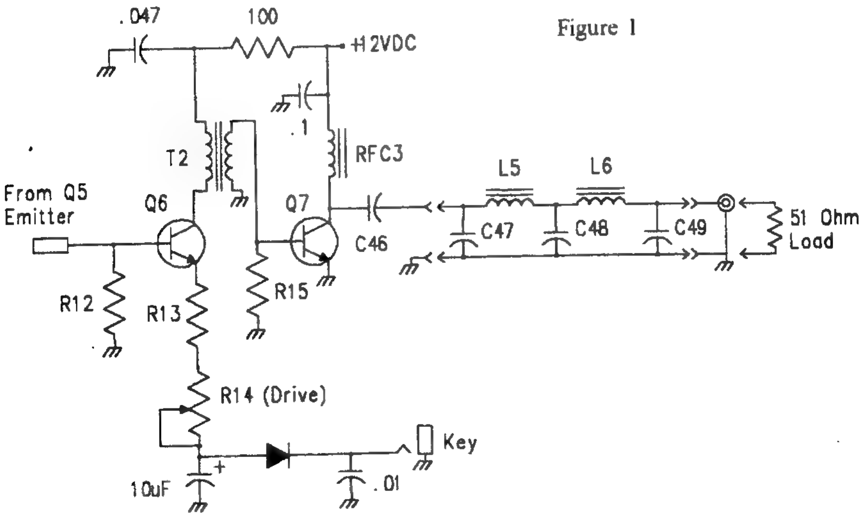


Table 1

Band	Q6 C	Q7 B	Q7 C	C47	C48	C49	Output Power
40M	15V	1.8V3	30mA	37V	38V	30V	2.3W
30M	15V	2.0V	290mA	32V	30V	22V	1.2W
20M	13V	1.8V	300mA	34V	32V	30V	2.3W

Note: All voltages are peak-to-peak readings.

Table 2

Modified Sierra 30 Meter Operating Conditions

Line #	V Q6C	V Q7B	Q7 mA Ic	C47V	C48V	C49V	Pout W	Eff %
1	15	2.0	290	32	30	22	1.2	34
2	15	4.0	320	33	30	25	1.6	42
3	14	4.0	330	40	42	32	2.6	65
4	14	4.0	380	40	50	36	3.2	70
5	15	4.0	460	42	54	40	4.0	72

Note:
All Lines: Vcc = 12VDC, T2 Ratio = 12T Pri : 3T Sec
Lines 1, 2 and 3: L5 = 16T, L6 = 16T
Lines 1, 2, 3 and 4: C47 = 330pF, C48 = 560pF, C49 = 300pF
Liens 4 and 5: L5 = 15T, L6 = 16T
Line 5: C47 = 110pF

Table 3

Breadboarded 30 Meter Operating Conditions

Line #	V Q6C	V Q7B	Q7 mA Ic	C47V	C48V	C49V	Pout W	Eff %
1	16	4.0	250	33	42	30	2.3	75
2	18	5.0	330	40	36	34	2.89	73
3	15	4.0	320	32	52	36	3.24	84
4	17	4.0	400	44	56	40	4.0	83

Notes:
All lines: Vcc = 12VDC, T2 Ratio = 12T Pri : 3T Sec
Lines 1 and 2: L5 = 16T, L6 = 16T
Lines 1, 2 and3: C47 = 330pF, C48 = 560pF, C49 = 330pF
Line 3: L5 = 15T, L6 = 16T
Line 4: C47 = 110pF

These results are for power saturated conditions where the PA drive potentiometer R14 is just backed off from maximum power out as seen on a scope across a 50 ohm resistive load. Note that the only initial questionable condition is for 30 meters. This further apparent when the efficiencies are considered: 40M = 57%, 30M = 34%, 20M = 63%.

The 30 meter transmitter tuned circuits were carefully peaked and in the process it was found that only one peak was found on both L3-C33 and L4-C36 tuned circuits. There should be two peaks when tuning either C33 or C36. A signal generator and a scope with high impedance probe was used to determine that each of the above tuned circuits was resonating too low. So 5 turns were removed from both L3 and L4. This allowed two peaks to be found on 30 meters, whcih now peaked identically to the 40 and 20 meter boards. The Sierra 30 meter Voltage (P-P) of Q7 B increased from 2.0 V to 4.0 V, resulting in a slight improvement in power output and efficiency: 1.6W and 42% efficiency. The resultant operating conditions are given in Line 2 of Table 2.

All of the Sierra modifications will be incorporated in Table 2 along with the appropriate notes so that before and after comparisons can be easily made. This includes the original Sierra 30 meter operating conditions (line 1). The same procedure will be followed with the breadboard data (BB).

At this point it was decided to try some of the suggestions given by others in QRPp along with some ideas of my own. The

best way to do this was to duplicate the Sirra driver, power amp, and output filter on a Breadboard (BB). This is much safer than removing components from the Sierra unit. Included on the BB was a crystal oscillator with an adjustable output voltage to drive the Sierra circuitry. The 30 meter circuitry was breadboarded because it still needed improvement especially in the efficiency area. Most improvements, if any, should also work for 40 and 20 meters.

The breadboard Q6B driving signal was set identical to the Sierra drive (4V peak-to-
peak) along with Vcc = 12VDC. The coils and capacitors were identical except for the output filter capacitors which were silver micas (what I had on hand). The following breadboard results were obtained. See Table 3, Line 1.

The output power is almost one watt higher (2.25W vs. 1.6W) on the breadboard circuit than the Sierra rig with less breadboard current being drawn (250mA vs. 320mA) so the breadboard efficiency improves (75% vs. 42%). Now the task is to get the Sierra rigoutput and efficiency up to the breadboard values. The first area to check is the Sierra output filter whcih has ceramic capacitors. The Sierra output filter on the plug-in board was connected to the breadboard with four one inch #16 stranded wires to replace the breadboard outpout filter. The results were very poor with the output less than half a watt. The Sierra output filter ceramic capacitors were inserted in the breadboard output filter one at a time with the same results; loss of power and lower efficiency. Next, C47, C48 and C49 in the Sierra 30 Meter plug-in board were replaced with silver mica capacitors. The results were: VC49 = 32V P-P, 2.6 W, Q7C I = 330mA with an efficiency of 65%. (See Table 2, line 3)

It is evident that any losses in the path of he output filter circulating currents (long lead resistance losses and component I^2R losses) really affects power output and efficiency. Imagine the problems that Wayne had in designing the Sierra plug-in boards and associated PA circuitry so that the Sierra rig works as well as it does on all bands. My breadboard unit output filter performed well because of short ground paths, the use of silver mica capacitors, and no band changing.

Changing L5 and L6 (output filter coils) from T37-2 (16 turns) to T50-6 (16 turns) on the breadboard made no meaningful difference in operating conditions. Both T37-2 and T50-
6 (16T) are approximately 1.02uH according to the torroid charts in QRPp Dec. 1993.

The effects of changing T2 parameters will now be analyzed to see if any optimization can be obtained. It is realized that to cover the frequency range from 160 to 10 meters, a compromise coil winding and core will have to be used. This is what Wayne referred to in his rig description. In my case where my interest is mainly in the 40/30/20 meter bands, optimization in the 30 meter band is expected to be sufficient. Changing T2 secondary from 3 turns to 4 turns caused a slight decrease in Q7B voltage whch slightly decreased output power. I suspect that T2 primary had additional loading because the primary voltage also decreased slightly. The winding configuration (Pri 18T : Sec 5T) suggested by Dave Meacham, W6EMD (2) was now tried. The same loading problem as above was found. Reducing the secondary turns from 5 to 4 turns reduced the loading so the power out was essentially the same as the power out obtained with the original T2 winding. My feeling is that 160 and 80 meter operation would be better with this winding but I don't know about 10 meters. For now I will stay with the original T2 coil. In addition I found that reversing the T2 secondary had no meaningful effect on output power and waveshape on Q6 Collector. In one phase there was another waveform (mostly third harmonic) riding on the primary (desired) waveform. The

PA output waveform was not changed in any meaningful way at least after being filtered by the low pass output filter.

The best phasing was when the primary winding connection to Vcc and the secondary winding to ground were on the same side of the toroid. Also, connecting a small mica trimmer capacitor (approximately 50pF) across the secondary and adjusting for the cleanest waveform on the collector of Q6 seemed to have a small effect on waveform and stability but nothing meaningful. This result may be different at higher power and higher frequencies where the Q7 base inductance may effect stability.

Next, changing Q6 from the 2N2222A to a 2N2219A did not give any meaningful improvement. This also held true when Q6 was forward biased to about 30mA DC.

Now it is worth while to evaluate the output low pass filter for harmonic removal. Not having a spectrum analyzer, I have to use indirect methods to estimate if unwanted harmonics may be a problem. The first method is to observe the waveshape at the PA collector (C47) with my 20MHz scope. On bands below 20MHz the collector waveshapebegins to look triangular rather than sinusoidal when driven to maximum power out. The symmetry indicates that some third harmonic energy is being added to the fundamental (the waveshape is symmetrical about the vertical axis). On C48 (the middle filter capacitor) the waveshape looks more sinusoidal with some peak-to-peak amplitude increase. On C49 (the output capacitor) the waveshape looks like a nice clean sinusoid with a decrease in peak-to-
peak amplitude.

The second method is to connect a signal generator with an approximate 50 ohm output impedance and constant amplitude to the input of the low pas filter at the collector (collector circuit disconnected) and a 50 ohm resistive load to the filter output. connect the scope along with an RF diode voltmeter at C47, C48, and C49. The voltmeter is a check on the scope to make sure that the scope's frequency response does not give misleading results. it is realized that the voltmeter responds to total amplitude, fundamental and harmonics so care must be taken in making comparisons. Even so with some experience the RF voltmeter alone can be meaningful tool for a beginner with little or no test equipment - see Sierra manual for examples. I also hear that Jim Pepper, W6QIF, may have an RF signal generator in the works, (3). I found that I needed a fairly large signal amplitude 3 to 5 volts peak-to-peak) in order to get a usable result over a wide frequency range. I was able to do this because I had a breadboard version of Doug DeMaw's, W1FB, Multipurpose Instrumentation Amplifier. (4) This amplifier has roughly 40 dB gain, is reasonably flat from 250kHz to 80MHz, and ahas 50 ohm output impedance. The frequency of the 30 meter lowpass filter showed a null (approximately zero volts on the scope and the RF voltmeter they tracked), at 19.3 MHz on C47, null at 18MHz on C48, and a null at 16MHz on C49. these results seemed very satisfactory to me even though I realize that output can rise again beyond the nulls. Again note that the approach used here is on learning and understanding what is going on. It would be nice to run this response on a computer and plot the results. I did some of this on a hand calculator as described under "Ladder Networks" in recent editions of the ARRL Handbook. This step-by-step circuit simplification and impedance transformation is somewhat tedious by hand, but very simple on the computer whcih I do not have. You can not beat the "by hand" method as a learning device especially if you want to try and increase power by changing the impedance tht the PA collector sees; i.e. transform the 50 ohm load to a lower PA load than is now seen, transistor and PA drive willing.

Before trying to increase power, I

should goin the group and apologize to Wayne Burdick, N6KR, for messing with a nice conservative design that gives 2+ watts with practically no heating of the transistor and good stability. My excuse, of course, is that this is a learning exercise. This allows me to try to optimize and maybe give an extra nudge where I may squeeze an extra watt or so without much effect on transistor heating or circuit stability.

My literature research (5, 6, 7) indicates attention should be paid to the PA and Driver transistors, PA drive voltage, PA load/output filter and associated factors such as heat transfer, stability, saturation, and harmonic reduction. Most of the references available to me were created wholly or in part by Doug DeMaw, W1FB and he should be given full credit for advancing the home brewer's education and enjoyment - God Bless!

Again, the breadboard is the ideal tool for investigating the above areas to optimize for a pwer increase. The meaningful maximum 2N3553 ratings are Vcdo = 40 Vdc, Veb = 4.0 Vdc (forward and reverse), IC = 1.0A Dc, Pd = 7.0 W and output capacity = 8pF. Both the 30 meter breadboard and the Sierra rig operate conservatively within these ratings as theabove operating conditions show (see Table 2, Line 3 and Table 3, Line 1). the parameters that I watch while experimenting were Veb, Ic, and Pd. A conservative PA design is to operate the collector plate dissipation at 50% of maximum. The approximate Sierra PA collector dissipation is Pd act = Pin - Pout. this is Pd act =3.48W – 2.56W = 0.92W. This assumes no losses in the output filter. Even with the approximations there is still plenty of room to experiment expecially as the PA transistor was barely warm to the touch over a reasonable time frame. The breadboard characteristics were better because it had a better efficiency.

The simplest parameter on the breadboard to test was the PA drive because the drive to the Q6 driver was adjustable. The results obtained were 2.89W power out with Q7 B peak-to-peak voltage equal to 5.0V. (See Table 3, Line 2). these results could not be obtained with the Sierra unit because the maximum drive did not go that high (5V P-P). Modifying the driver and T2 to accomplish this will be held in reserve in the event other simpler methods cannot be found.

The usual output filter tuning techniques of compressing and spreading the turns of L5 and L6 was the next thing to try on the breadboard. Compressing L6 turns caused a slight increase in output power while spreading L5 turns caused a slight decrease of output power. However, spreading the L5 turns had the best power increase. L5 turns were deceased to 15 turns and the results recorded. (See Table 3, Line 3.) There was approximately 1 watt of power increase for a total of 3.24 watts with an efficiency of 84%. This seems to indicate a close to optimal match between the PA collector impedance and the load presented by the output filter. The same thing was doen on the Sierra rig with also close to 1 watt power increase to a total of 3.2 watts with an efficiency of 70% (see Table II, Line 4). However, I still want to know "why" so the next step is to analyze the impedance transformation through the low pass output filter to see what impedance the PA collector actually sees.

The component impedances of the low pass output filter for 30 meters and their separation into two PI filters is shown in Figure 2. Note that C48 is separated into two parts so the impedance transformation can be more readily understood. This low pass output filter is a slight variation of the one-half wave filter which repeats the load and has all the component impedances identical. The slight increase in inductor impedance gives an increase in Q and makes iteasier to fine tune the filter (compressing and expanding inductor turns spacing on the toroid) so that internal capacitances such as Ci (collector capacitance)

Figure 2

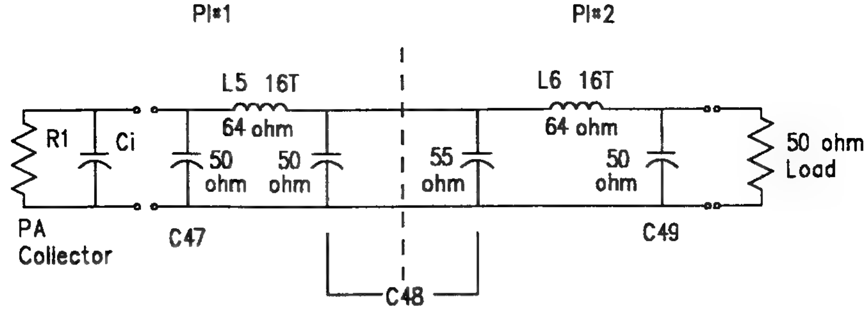
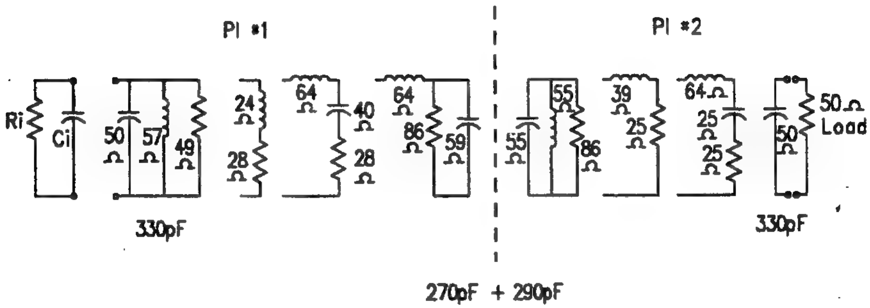


Figure 3



can be absorbed as part of C47. (8, 9, and 10) Q gets critical when impedance transformation ratio is low. the parallel toseries circuit conversion and its reverse is the way filter computer design is usually performed. The computer advantage is that a small change can be made and the new results quickly obtained. However, if you are like me with only a hand calculator and don't mind the number crunching, quite a bit can be learned about the "why" which is what I am after. An example of this technique on the above low pass output filter is shown in Fig. 3.

The 50 ohm load impedance is transformed through PI filter #2 to present a resistive value of approximately 86 ohms to the output side of PI filter #1. This filter in turn transforms the 86 ohm resistive load down to a reistive value of approximately 49 ohms which becomes the load that the PA collector sees. It should be realized that what has been shown is the "one way" impedance transformation from 50 ohms on the right through two PI filters to present an approximate 50 ohm load to the PA collector. It does not show the effect of the collector's resistive impedance (Ri) on the above impedance transformation. This effectgets complicated as can be seen in references 9 and 10. Suffice to say that if the circuit q stays above certain limits, the above transformations hold true. Otherwise, the output power and PA efficiency would decrease significantly. the relationship between Ri and the transformed load impedance is the main factor controlling output power assuming adequate PA drive and gain. Some changes will be made below to the transforming impedances to see

if the output power can be increased. Generally PA collector capacitance (Ci) is low enough so that it can be absorbed by becoming part of C47. This is where filter tuning under operating conditions can be meaningful. More on tuning below. Ri is in the order of 50 ohmsor less in QRP PA amplifiers when the transistor is operated in or near saturated conditions and can be less than 10 ohms in high power amplifiers.

It is easy tosee what happened to the transformed load impedance when lossy capacitors (I^2R losses) as found in the above 30 meter plug-in unit; not only was there resistive losses but the transformed impedance went up causing less power to the load and more power being dissipated in the transistor. down goes efficiency and upgoes transistor temperature.

One way of seeing if the low pass output filter is really presenting a 50 ohm load to the PA collector is to use the method described in reference 8, chapter 4 - Matching Networks for pretuning an output network using a 50 ohm impedance bridge and a low level RF signal source. First remove all power from the unit. Second, temporarily connect a 50 ohm resistor across C47. Third, connect the output of the 50 ohm impedance bridge to the low pass output filter load teminals and its input terminals to the low level RF source.

First, connect the output of the RF signal source (10.1MHz) across the bridge and adjust its RF output for maximum deflection on the bridge meter (1.0mA in my case). Second, remove the Sierra plug-in unit from the rig and connect a 51 ohm resistor across C47. Third, connect the bridge output across C49. Observe the degree of nulling. There probably will be about 1/4 scale deflection on the bridge meter because the collector capacitance (Ci) and any stray capacitance are missing. In my case the meter read 0.15mA. Compressing L6 turns reduced the meter reading to 0.08 mA. Adjusting L5 had no real effect. For comparison I read 0.2mA with 100 ohms across C47 and 0.3mA with 33 ohms across C47. also with 51 ohms and a 110pF capacitor across C47 the meter read practically zero. 100 to 200 pF sounds like a good dynamic value for Ci when the power out is in the order of 2 watts. The transistor manual value of 8pF must be for a class A amplifier?

I have a breadboard version of Doug Demaw's "Field Tester for Antennas" (11) modified for 40/30/20 meters. This unit has a built-in RF source and 50 ohm impedance bridge along with being tuneable. It is a natural for this type of experimentation. When I evaluated the PI networks I used when building the unit, I found that it was not very effecient. My new knowledge allowed me to make some quick changes which almost doubled the power output and improved the efficiency.

The power transfer through the low pass output filter can now be determined using the calculated impedances and the measured voltages across C47, C48 and C49.

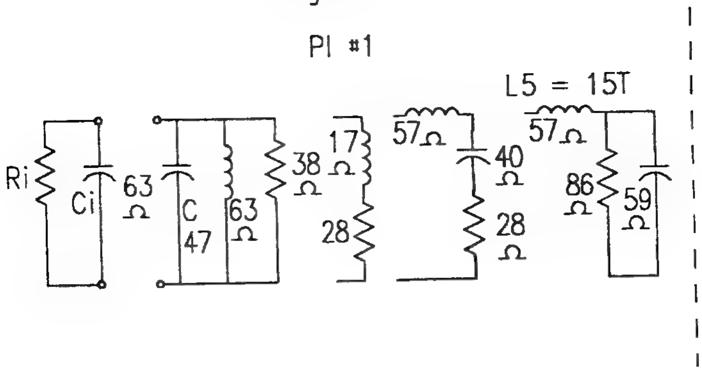
P = VP2/2R: P C47 = 2.72W, P C48 = 2.56W, P C49 = 2.56W

The loss of power going through PI #1 network (0.16W) can be accounted for by the filtering of the harmonics by PI #1 filter. Power transfer through PI #2 filter shows no meaningful losses indicating tht the component losses are very low (bless those silver micas). The relationship Pload = (I^2)(Rload) and Pcollector = (I^2)(Ri) can be used to determine that Ri = 14 ohms. This lower than I would expect for a QRP PA but it could account for theefficiencies up in the 70% range. It also indicates that the PA drive is strong enough so that the transistor peak currentis near saturation.

This operating condition is good for taking the next step; namely changing the impedance transfer throught the low pass output filter so tht the PA collector sees a load impedance of approximately 30-40 ohms. the simplest initial approach is to

Figure 4

PI #1



leave PI #2 alone and see if PI #1 can transfer 86 ohms to about 35 ohms. The new PI #1 diagram is shown in Figure 4.

The breadboard low pass output filter circuit was changed to match the PI #1 circuit shown in Fig. 4. L5 = 15T, C47 = 110pF. Also the PA collector was disconnected from the lowpass output filter and a 33 ohm resistor placed in parallel with C47. Now the "Field Tester for Antennas" was connected as above and the bridge meter observed to read 0.3mA. Several capacitors were paralleled across C47 one at a time until a 330pF capacitor was found to give a null of 0.05mA. this was evidence that the 110pF along with Ci was a good ballpark capacity to start operational tuneup. The test equipment and the 33 ohm resistor were disconnected, PA collector reconnected and power applied with PA drive set for just discernible power output across a 50 ohm resistive load. Adding additional capacity to the 110pF (C47) capacitor did not give any increase in power so C47 was left as is. The PA drive was now increased until the output across the 50 ohm load was 40V peak-to-peak which is equivalent to 4 watts. PA Ic was 400mA giving an efficiency of 83%. Operating condition values are shown in Table 3, Line 4. The PA transistor felt fairly warm to the touch after about 30 seconds of steady operation. Now the same low pass output filter was set up on the Sierra plug-in unit, the unit installed in the rig, and the same procedure used to bring up output power to the same value (4 Watts), PA Ic was 460mA giving an efficiency of 72%. Operating condition values are shown in Table 2, Line 5. The PA transistor was beginning to get hot after 30 seconds. The operating conditions of Table 2, Line 4 mode made the transistor fairly warm after 30 seconds. When making this heat test my finger was on the top body of the transistor.

When I moved my finger to the black fins of the star heat sink I could barely feel any heat even when the top of the body was getting hot. When I put thermal compound on the transistor sides I found tht with 4 watts output the transistor top body got fairly warm but not hot after 30 seconds. The fins of the heat sink still did not get very warm. A quick test was made at 4 watts sending just dashes at about 20 wpm for 1 minute. the transistor body top got quite warm but the system was still useable. Some days later I replaced thestar heat sink with a top hat heat sink that fit snugly around the thermal compound coating on the transistor body. On steady state testing the transistor body and fins got quite warm after 45 seconds vs 30 seconds for the star heat sink. Sending steady dashes for 1 minute caused the body and fins to

get fairly warm but very useable. This heat sink was a significant improvement.

Some comparison tests were made on Jim Pepper's DC transceiver. (1) Here I found that for a steady 4.0 watts ouput for 30 seconds the transistor flange of the IRF510 got quite warm but not hot - quite useable. The interesting fact here is that the simple aluminum rectangular 1-3/4 x 1 inch strip used for a heat sink got quite warm also indicating that it was doing a good job carrying off the heat. Heat sink compound was used here and a good bond was made to the transistor flange. The same general heat sinking method using a grounded copper strip was used by Dave Meacham, W6EMD in his 5 Watt mod for the NorCal 40. (2) I plan on more on-the-air testing at both 3 and 4 watts using the finger test to find my temperature comfort zone. Now with 4 watts I can start working on my psychological powerbarrier as well.

The same power output enhancement procedure that was performed on the Sierra 30 meter plug-in low pass output filter was now repeated on the Sierra 40 meter plug-in board. This included all the above analysis and breadboard testing of results before they were incorporated in the 40 meter plug-in unit.

The low pass output filter values used in the original 40 meter unit present an approximate 50 ohms load to the PA collector and transfers 2.3 watts of output power to the 50 ohm resistive load. The same procedure of only modifying the PI network components closest to the PA collector was tried again. The intent is to transform the resistance (68 ohms) that appears across C48 down to 30 to 40 ohms across C47 which is the load the PA collector sees. As stated before there are numerous combinations of components that theoretically will achieve this result. However there are practical limits on Q that need to be satisfied in order to achieve the above impedance transformation. (10)

Computer programs iterate values to get practical values of components along with checking frequency responses. I tried four cases, three which worked and one which did not when actually tested on the breadboard. The simplest one required only changing L5 from 18 turns to 16 turns. The results were Ic = 460mA at a Vcc of 12V DC, V C49 = 40V P-P, Power out = 4.0 Watts and an efficiency of 72%. The same finger temperature tests were performed and found to be basically the same as in the 30 meter case. These results satisfied my aim so nothing further was done.

Finally, I realize that some of my comments are subjective and based on information that is not complete and/or fully understood by me. Therefore, some folks will take exception and disagree. I think tha is fine as long as they let our editor know so he can print corrections and clarifications. I want to learn and this is a good way for all of us to upgrade our knowledge. 72-73, John Pratt, N1UA

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9. "Collector Matching Networks", Mark Bacon, KZ9J, Ham Radio, January 1989.
10. "New and Improved Formulas for Design of PI and PI-L Networks", Elmer A. Wingfield, W5FD, QST, August 1983.
11. "Field Tester for Antennas", Doug DeMaw, W1FB, QST, March 1986.

NorCal QRP Club "QRP to the Field Contest Results

by Bob Farnworth, WU7F
6822 131 SE
Bellevue, WA 98006

I had a ball, I hope you had a lot of fun doing the contest. Fifty logs were sent in for a contest that was hatched late December and early January. It was a fantastic turnout for such short notice. Field Day and QRP Afield also had good turnouts from the QRP ranks. I believe it indicates a QRPer generally enjoys the field type operations, and for QRP to the Field, there were thirty-three stations out in the field. the roller coaster propagation conditions on twenty kept activity somewhat low, but forty was a hot bed of activity.

A total of 1115 contacts were reported. Over fifty percent of the entries used homebrew rigs, and a number of those were under 1 watt for the contest operations. Thanks goes out to the many home stations that provided contacts to those out in the field, among those were KP4DDB and W6UMP on CW, and KI6DS on SSB. The many expeditions, included the New Mexico group to Mount Baldy, the Texas group to Sugarloaf Mountain, and Utah group to Antelope Island in the Great Salt Lake. It was still cold in many parts of the country for the first of April, but Craig, WB3GCK, in cold, cold Pennsylvania, stuck it out and made a big score of 2070 points to take the lead in the contest. Next year, a few changes are in the works and notice of the contest will be made early enough to catch the newsletters and magazines. Thanks toall that participated, I look forward to working you on Field Day or the "QRP Field Contests". 72, Bob, WU7F

NorCal QRP Club
Spring QRP to the Field
April 1, 1995 Contest Results

Call	QTH/SPC	Q's	Score	Rig	Power	ANT
1 WB3GCK	Field/PA	46	2070	40-40	950mW	Inv. V
2 KC6EIJ	Field/CA	37	1665	NC40	1W	Dipole
3 KI6SN	Field/CA	35	1575	NC40	1W	Inv. V
4 AA6AV	Field/CA	29	1305	40-40	950mW	1/2Sloper
5 KK6IU	Field/CA	76	1215	NC40A		Skelton
(+KI6PR & AC6LS				QRP+	5W	Cone
6 N6WG (+WA6NAE)	Field/CA	42	945	NC40A	2W	Dbl Loop
7 W6EMT (+WU7F)	Field/WA	34	683	HBW6EMT	5W	Yagi
8 K4XY	Field/VA	43	645	FT-757	5W	Dipole
9 AB6NZ	Field/CA	41	615	Delta II	5W	R7 Vert
9 W6UMP	Home/CA	41	615	Sierra	1W	Zepp
WA0RPI	Field/MN	23	518	HW9	3W	L.W. Kite
AF5U	Field/AZ	23	518	OHR Cl.	5W	Dipole
WA2CRQ	Field/CA	22	495	HW8	2W	Inv V

K6BSU	Field/CA	21	473	HBK6BSU	3W	Zepp
W5ORM	Field/TX	15	450	FT757	500mW	AV5Vert
NA5K (+ W2LQ K5JHS, N5OSG, K5JHP)	Field/TX	29	435	Argo II	5W	Dipole
K2SJB	Home/NY	29	435	NN1G	1W	
KG0TW	Field/MO	27	405	TS430S	5W	Dipole
W5ES (AB5WB & AB5TZ)	Field/TX	27	405	MFJ9020 MFJ9420	4W	Inv. V.
KD4PUP	Field/VA	27	405	MFJ9040	4W	Dipole
KC1FB	Field/CT	9	405	40-40	<1W	E.F.Wire
NA5N	Field/NM	18	398	HB	5W	Dipole
KK7C	Field/UT	24	360	Argo509	4W	Wire
KG6VI	Field/CA	24	360	PM3-A	5W	
KD6ORH	Field/CA	23	345	MFJ9020	4W	Isotron
N4JEO	Home/VA	21	315	NC40A	1W	
N7ANT	Field/VA	20	300	FT757	5W	
VE7QK	Home/BC	37	278	Epiphyte II	5W	Inv. V
KI0G/Mobile	Mob/CO	10	225	NC40A	<5W	Hustler
KP4DDB	Home/PR	45	225	Argo II	5W	Yagi
KT3A	Field/PA	5	225	NC40	1W	Inv. V
N1IRZ	Field/NM	14	210	QRP+	5W	Dipole
VE7ZM	Field/BC	9	203	HB VE7ZM	5W	
VE7BLU (+VE7MAA & VE7BAY)	Field/BC	8	180	HW8	<5W	102' Cntr Fed Wire
AB5WT	Field/NM	8	180	NC40	2W	Zepp
WA4NID	Field/NC	8	180	Sierra	1.5W	Walkstik
KG7FC (+NZ7X)	Field/UT	7	158	K9AY	5W	Dipole
K5HT	Field/TX	9	135	MFJ 9017	4W	HB Vert
W6PRI	Home/CA	24	120		4.5W	
W6RCL	Home/CA	16	120	NC40	2W	HF2V
W0CH	Home/FL	12	120	TS530S	1W	Zepp
N6GA	Home/CA	15	113	Sierra	2W	Yagi/Dip
AB6SO	Home/CA	14	105	NC40	1.8W	Dipole
KB7BEJ	Home/AZ	18	90	Scout	5W	5BTV
VE7JO	Home/BC	12	90	VE7JO	5W	
WA6GER	Home/CA	15	75	FT301S	5W	5BTV
W3TS	Home/PA	5	75	W3TS	950mW	Inv. V
KB0HPH	Home/CO	8	60	HW-8	2W	
W6HPK	Home/WA	8	45	HB	4W	Zepp
WB6FZH	Home/HI	2	30	Cent21	5W	Vert

SoapBox: Bob and I had a good time setting up a big antenna (40M Dbl-Loop 113 ft. long), Now will know what to do when Field Day gets here. We will look forward to the event again next year. **N6WG (Dwight, WA6NAE)**. My first time to work QRP/P CW. I really had a good day. Nice people to chat with plus some DX (S92SS & XE1/AB5VI). **George, K5HT**. Conditons very poor here for a while but return to SF Bay area periodically. **Greg, WB6FZH/KH6**. First mobile QRP experience. Great event. Do it again. **Bob, KI0G**. Was it an April the first trick or what? Age is 72 and still get surprises. **Ken, VE7BLU**. Nice contest. Worked many new stations. 40M CW was great. **Bill W6PRI**. Station elevation was 10,700 feet. Worked coast to coast and 10 states. We had fun. Thanks NorCal for this contest. **Dave, N1IRZ/5 (South Mt. Baldy Expedition)**. I had an hour free over the contest period. I "sprung" antenna up in 12 minutes, down in about 8. It was worth it even for the short time. **Cameron, KT3A**. Conditons seemed very good - wish I had more time. **Cam, N6GA**. Cut it short due to wind and cold. However, had a great time. this would be fun to do again. Did not hear one other station working thsi contest, April Fool? **KG7FC (Greg, NZ7X) Antelope Island, Great Salt Lake.** Too bad contest ended at 2400Z. Using NorCal 40, terrific little radio. **Alan, W6RCL**. Forgot about contest. Next time I will be ready. **Vic, AB6SO**. My first QRP contest. Great contest, had fun. I can hardly wait for the next time. **JC, KC6EIJ**. All contacts on 14.060MHz with HW8 at 2W. **Jane, KB0HPH**. Thanks for contest, met some new people. It was a great day, 25 degrees and snowing. **Doug, KG0TW**. This was a lot of fun for this EE, age 67. **John, W5ORM**. Thanks to NorCal for a very nice contest. Honey-dos and work call-ins should have been multipliers!! **Rus, KB7BEJ.** Inverted V on protable mast, battery operation with solar panel. **Richard KI6SN.** Call it spring, but it was winter cold. Thanks to NorCal for fun event. **Jim KC1FB**. Great test, we kept the rules and had fun. **Jim, KK7C**. Total time two and half hours, set up in back yard. **Floyd, K6BSU.** I really wanted to give the NC40A a workout. Nice impression when you can tell another station you're running 1 watt from homebrew rig and carry on a long qso with solid copy. **Robert, N4JEO**. Backpack field day? Heard about QRP to the Field, perfect practice. **Peter, AA6AV**. My 1st contest in 65 years of operating. Had a ball. **Bob, W6UMP**. Had to QRT at noon. fun morning! **Jim, WA6GER**. Thanks for contest. My first and I had a great time. First time I've called CQ QRP and got an answer. **Rob, AB6NZ**. Mother nature threw me an April Fools joke. 9 AM had snow. Hoping it would warm up, almost hit 40 degrees. **Jim, WA0RPI**. Wind picked up my 15' mast, and isotoron antenna. Portable picnic table started to fold up with me inside. But I'm ok now. Perhaps in need of some refinements. **Eric, KD6ORH**. First QRP contest, thoroughly enjoyed it. Thanks NorCal. **Jerry, KD4PUP**. Weather conditions in Florida not too good for field. Perhaps next contest I can make it to the field. Thanks for great contest. **Dave, W0CH**. the peak we operated from was accessible only by foot, approximately 5200 feet. 70 degrees and partly cloudy. **El Paso ARC, W5ES (Andrew, AB5WB) Sugarloaf Mountain Expedition.** I was bound and determined to get out into the field. I made it and I had a ball. Excellent opportunity to field test home brew gear. Can't wait for next QRP Field event. **Craig, WB3GCK**. 40 meters using 2 rigs, NC40A and QRP Plus. **Kent, KK6IU (Mt. Bullion Expedition).** Had contest gone on another couple of hours, there would have been 200 more potential contacts (75M SSB), evening BC nets. **Derry, VE7QK**. It was still wintertime above timberline in New Mexico. Wind blew entire time and cold (41 degrees), beat

us. About 1600Z retreated to warmer ground. Contest was fun, had a great time **Paul, NA5N and Doug, AB5WT, Mt. Baldy Expedition.** Location - Point North Park, Richardson, Texas. **North Texas QRP Club, Smitty, NA5K, Baity, W2LQ, Bud, K5JHS, Karry, N5OSG, & Bill, K5JHP.** Location was on the Edwards AFB Desert Test Range. **Jim, KG6VI.** Had fun, hope to get in more next year. **D.A. Michael, W3TS.** Operated from Saguaro Lake Park, AZ. Conditions were tough! **David, AF5U/7.** Operated only a couple of hours (at a retreat). Had great fun! **Dave, WA4NID.** N6KR and I operated out of a motorhome, grid square CM87UK. I look forward to the next QRP to the Field. **Wes, WA2CRQ/6.** How about Q's x sections, 1 point qso is no fun. Looking forward to next one. **Dave, K2SJB.** Suggest contest run later into evening. **Bruce, VE7ZM**

QRP to the Field

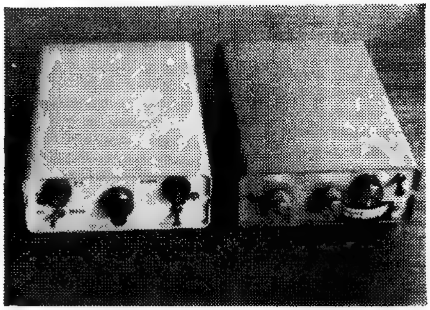
by Floyd Carter, K6BSU
2029 Crist Drive
Los Altos, CA 94022

Individual Contest Results 1 April 1995: 1600Z to 2400Z. All contacts claimed were performed on 40 Meter CW, Single Operator. The total operating time was about 2 1/2 hours because ofanother committment during the day.

Station: 40 meter homebrew CW transceiver of my own design, with a separate homebrew antenna tuner. Power output = 3 watts. The transceiver operates from 10 self contained AA Nicad cells, which ran down at about 2300Z. The remainder of the contest I used a 12 volt Gell Cell. The antenna was a temporary 66' end fed Zepp at 15 ft. Fed with 33' of TV twin lead.

Site: Had to set up in my back yard, because I had to be away from 9 AM til 2:30PM.

Score: 22 qsos on 40M CW x 5 (under 5 watts) x 3 (field operations) x 1.5 (homebrew) = 495
72, Floyd



HB Transceiver and tuner by K6BSU

QRP to the Field

by Eric Bikales, KD6ORH
10188 La Canada Way
Shadow Hills, CA 91040

I set my portable station up ontop of a large hill about a quarter mile from my

KD6ORH's Portable Setup

house. Quite a few hills around my neighborhood are undeveloped and used only for horseback riding. anyway, I had a clear shot in all directions and only had a couple of near catastrophies, like when the wind picked up my 15 foot mast and antenna, and my portable picnic table started to fold up with me inside it. But I'm ok now.

I used an MFJ 9020 (5 watts on 20 meters only) operating on Nicads and an Isotron 20 meter antenna up on a 15 foot mast (stuck through the umbrella hole of the plastic picnic table - a system with a lot of possibilities but perhaps in need of some refinement.

My score:

23 Qso's x 5 x 3 = 345 points.

72, Eric

QRP to the Field

by JC Smith, KC6EIJ
1249 Dewing Lane
Walnut Creek, CA 94595

Great contest! I really had fun. got a late start, but the hottest action seemed to be in the afternoon anyway. The morning was highlighted by a bit of ragchewing in with scoring a few points.

JC Smith Operates QRP to the Field

I set up in a tent in my yard and installed my "N6YQD Lite Gear" portable dipole (see Terry's article in Sept. '94 QRPp) between two nearby trees. Power was by gel cell, charged by the sun. I'm sure I didn't need to charge it for an eight hour contest using a NorCal 40, but I thought I would use my memory keyer, and it draws more power than the rig.

This was my first QRP contest, actually my first contest of any kind except for Field Day. I guess I had visions of hot and heavy action. I ended up unhooking the keyer and just using the Oak Hills unit I built into my NC40. It has a much more pleasant sound (different weighting I guess) and I'm more used to it. Paddles were built from the Kent Engineers kit, so if you count kits, I was 100% homebrew. Even the solar charger, power monitor and distribution box were home made.

All of my operations were between 7.030 - 7.040, CW of course. Since I couldn't get the NC40 upto 5W, I turned it down to 1W for the extra points. Made 37 contacts, so that would be 370 qso points. Field location andhomebrew would be x 3 andx 1.5 so: 370 x 3 x 1.5 = 1665 points. One band, one mode.

I can hardly wait for the next one. May even go on a real campoing trip next time.

72, JC Smith, KC6EIJ

Roy Gregson, W6EMT making a contact in the 1995 QRP to the Field Contest.

NorCal would like to thank Bob Farnworth WU7F for all of his work in making the QRP to the Field such a success in its inaugaral year. We will announce the date and times of the 1996 contest in the March issue of QRPp. Thanks again Bob from Doug, Jim, and all of the NorCal members. 72

The New Sierra

Wayne Burdick, N6KR
1432 6th Ave
Belmont, CA 94002

One year has passed since I completed the design of the Sierra, NorCal's multi-band transceiver project. Jim Cates, Doug Hendricks and Bob Dyer worked hard to get the parts kitted and rigs shipped, and by the end of 1994 over 100 Sierra kits were in the hands of club members. Now it's nearing the end of 1995, and once again I'm completing a design cycle. But this time it was a bit easier: all I had to do was revise the Sierra, not start from scratch!

The big news is that the Sierra will get to crawl out of the ooze and sprout real legs: thanks to new entrepreneur Bob Dyer, it has become the third product in Wilderness Radio's line of QRP gear. In fact, there should be spiffy two-tone blue Sierras en route to points world-wide by the time you read this.

More news, nearly as big is that the Sierra made it to the cover of the 1996 ARRL Handbook! My construction article on the Sierra appears inside. The League's acceptance of the article acknowledges the success of our club project, and it will really help put NorCal on the map!

In this article, I'll explain what changes I've made to the design. Some of the changes are simply the result of new tricks and ideas I've picked up, aided by Dave Meacham, W6EMD, Eric Swartz, WA6HHQ, and Walt Thomas, WA4KAC, among others. Other changes were necessary to elevate what was a good club project design to commercial quality. But the Sierra is still a QRP club project at heart—a compact rig with plug-in band modules that will run all weekend on AA cells!

Caveat: This article was written in October and some component values may have changed by the time you read it. If you're planning to make some of the modifications and would like to order a copy of the new manual (which will have the latest updates) call Bob Dyer (415-494-3806). Or write to Wilderness Radio, P.O. Box 734, Los Altos, CA 94023-0734. If you have technical questions, contact me at 415-592-2700 or 1432 6th Avenue, Belmont, CA 94002.

Physical Changes

The new Sierra will be the same size as the old, but will look and feel a bit different. Like the NorCal 40A, it will be professionally painted and silk-screened. More important, the chassis will be much more rigid, thanks to L-brackets that hold the front and back panels to the bottom cover. These L-brackets are welded to the panels, and secured to the bottom cover with four screws. Top cover removal is not affected; the usual plastic latches are still there.

Another physical change is the use of U-shaped covers for the band modules. Fabricated out of durable plastic, this cover will make it easier to insert and remove the modules, protect the back of the board, and give the module a neater appearance. The cover can be used with old band modules, too.

Transmitter Changes

I cut some corners in the original transmitter design to keep the cost low—appropriate for a club project. I've "put the corners back in," so to speak, with the re-design. The most important of these changes are listed below.

Note: Modifications #1 and #6 can be made to an original Sierra without causing any unwanted side effects. Mods #2 and #3 should be done together, and only after #1 has been completed and its effect measured. #4 may be useful in rare cases. #5 triggers many component changes and is included only for reference.

1. Improved VFO and crystal oscillator drive into pre-mixer

One of the biggest challenges in a multiband design is obtaining consistent signal levels at all stages and on all bands. This begins with the signals injected into

the pre-mixer , U7 (refer fig. 1). If these levels are too high, the pre-mix output will have high spurious signal content; if too low, transmit output power will be reduced. As it turns out, the injection levels can be increased somewhat from their original levels, resulting in higher, flatter pre-mix output from 160 through 10 meters.

To increase the VFO injection level without altering the VFO low-pass filter (R22/C61), I simply changed Q3 to a J309. (In fact all of the JFETs in the new design are J309s, which have much higher and more consistent transconductance than MPF102s or 2N4416.) To improve crystal oscillator injection, which had been on the low side with some crystals, I added R9 (fig. 1). This trick is described by the NE602 data sheet as a way to improve oscillator starting when the device is used at VHF, but it helps even at HF.

2. Improved pre-mix buffer stability on higher bands

Some Sierra builders found that on 15 meters and above the transmitter output would break into oscillation at certain power levels. I traced this to two components: the inductor in the drain lead of Q8 (now Q2); and the 47K band-pass filter termination resistor (R23).

Thanks to the increase in U7's output described above, along with the use of another J309 at Q2, I was able to reduce the value of R23 by a factor of 10 and reconfigure Q2 as a unity-gain source follower. The stiffer termination makes the filter easier to align and less susceptible to feedback from the transmitter output. Making Q2 a source follower eliminates RFC2 and the associated voltage gain that peaked at around 20MHz, which is no longer necessary. (And hey, it's one less toroid!)

Note: C5 (RX mixer injection cap) increases to .001uF in the new circuit, and C63 increases to 10pF.

3. Increased output from transmit buffer

The original transmit band-pass filter termination (R11) was quite high—12K—to compensate for minimal drive on the higher bands. With a new transmit buffer circuit in place (figure 2), I was able to eliminate C37 and decrease R11 to a stiffer termination of 5.1K. The logic for this is similar to that for reducing R23 to 5.1K in the pre-mix filter. Also note that this allowed C31 to be increased to 10pF.

The new transmit buffer circuit is a significant improvement. In the earlier, simpler design, there was nothing but a 390-ohm resistor from Q5 source to ground. This resistor was used to establish the drain-source current for Q5, but this in turn allowed the base bias voltage of Q6 to vary somewhat based on the particular device used at Q5. In the new circuit, the two 1N914 diodes in the source circuit establish a fixed bias level of about 1.4V for Q6. With the bias stabilized, the performance of Q6 is more consistent, and output is more constant across all bands.

Other changes made in conjunction with the new buffer circuit include the addition of C67 and C79, an increase in the size of C51, and the removal of 4 turns from the primary of the driver/PA transformer. The new 8 turn : 3 turn winding reduces the negative undershoot at the base of the PA transistor that we had seen on some bands. With 12 turns, the voltage developed at the driver collector can be excessive, leading to an undershoot of as much as high as -4.2 volts, which is too close to the Vbe reverse-breakdown voltage for comfort.

4. Improved driver keying

In the original driver emitter circuit, D10 was connected directly to R14. This meant that the device used for keying became part of the resistance in Q6's emitter circuit, and also the drop across D10 reduced the emitter bias voltage. Some keyers and keyboards have, believe it or not (I found this out the hard way) a resistor in series with the keyed output. In this case the keying

device itself could reduce the maximum output power available from the driver!

To completely isolate the keying device from Q6, I added Q8 and Q9. Together, these transistors form a non-inverting buffer with an open-drain output. When the key is pressed, Q9 turns off, allowing R12A to completely turn on Q8. Q8's drain-source circuit looks like around a 1-ohm resistor in this condition, so it has a negligible effect on Q6's emitter circuit. As in the old circuit, releasing the key allows C51 to charge, producing a smooth decay in output.

While the new driver keying circuit is more complex, it actually results in a net gain of only one component on the Sierra's PC board. This is due to the use of a 47K SIP (single-inline-package) at R12, which supplies the two resistors needed for Q9 and Q10 but also replaces two resistors from the original design (R9 and R10).

5. More consistent transmit monitoring level

On some bands, and at some settings of the drive level and RF Gain controls, the transmit monitor volume was too low. To solve this problem, I bit the bullet and added a true sidetone oscillator in lieu of direct TX monitoring, using the second half of the LM358 op-amp in the receiver. The sidetone oscillator is a standard square-wave oscillator, but the output is heavily rolled off so that the tone is near sinusoidal. The sidetone volume can now be adjusted with a trimmer, and the standard pitch of about 650 Hz can easily be raised or lowered with one capacitor change.

6. Misc. transmitter changes

The transmit 4.915MHz oscillator inductor, L2, has been increased to 18uH to allow the TX offset to be set to the middle of the receive crystal filter bandpass. Also, a few components in the bandpass and low-pass filters will change. See Dave Meacham's recent QRPp article (September 1995) for ideas, although final values may be different due to component availability constraints.

Receiver Changes

Receiver changes of interest are described below. The changes are minor and are not recommended for use in the original Sierra. Refer to the new Sierra manual for circuit details.

1. AGC threshold adjustment

Following the lead of the NorCal 40A, the AGC threshold is now adjustable, from no AGC action at all to complete silence. To make the AGC adjustable, I switched to an AC-coupled detector arrangement and used a potentiometer to provide a variable detector bias voltage.

2. Dual JFET mute circuit

Because the transmitter now uses a sidetone oscillator, I had to change the way the receiver gets muted. Muting used to occur in the I.F. Now, muting is handled by a pair of JFETs between the product detector and A.F. amp, as in the NorCal 40A. This also accommodates the MUTE line of the KC1 keyer/counter. (Refer to the KC1 manual for additional details on this modification.)

3. I.F. Amp output inductor swamping

I added a 1.8K resistor across RFC1 (now L2). This eliminated a tendency for the AF amp to "ring" a bit at very high volume settings. I also added two supply isolation resistors, one for the RX mixer and one for the I.F. amp.

Manual Changes

The new Sierra manual is nearly a complete re-write. This was necessary to give it a more "Heathkit" feel—instructions so complete that nearly anyone can successfully build and align the rig.

Among other things, I renumbered all of the inductors according to their physical characteristics. All of the prewound, solenoidal chokes now have "RFC" designators, and all of the toroids have "L" designators. In previous designs I've used "RFC" for inductors functioning as chokes even if actually wound as toroids, and "L" for inductors functioning as resonant ele

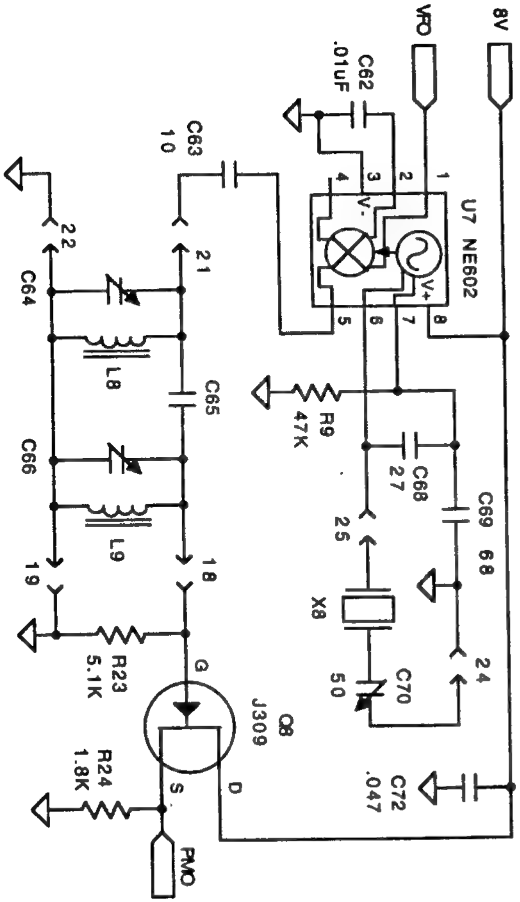
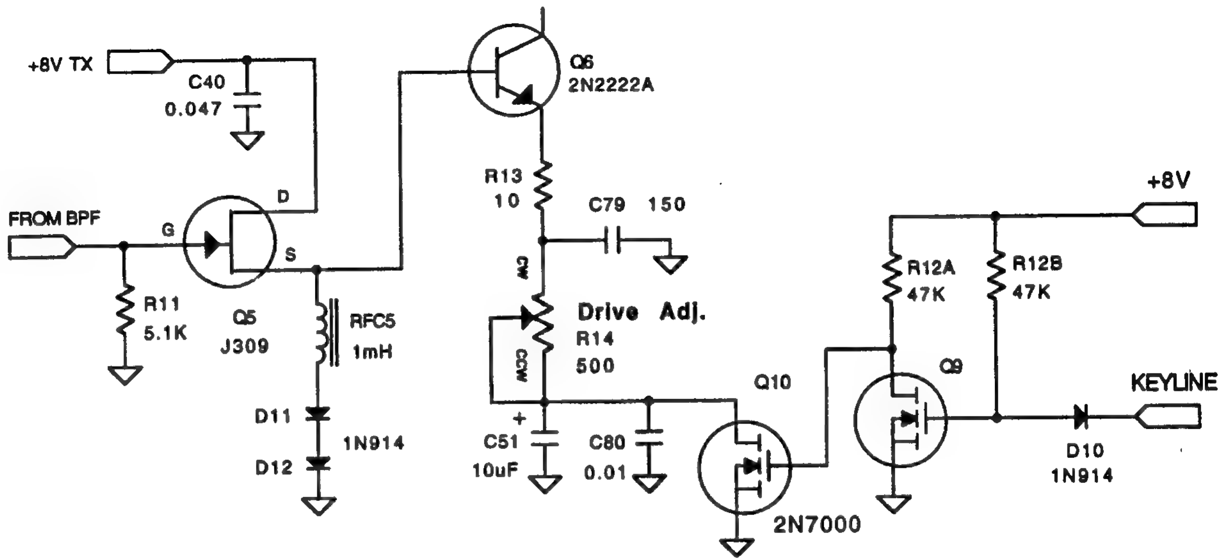


Fig. 1. New Sierra pre-mix circuit.

Fig. 2. New Sierra transmit buffer and driver circuit.



ments even if the were actually small solenoidal chokes. While the old method is more accurate from an electrical standpoint, it is confusing for some first-time builders.

Conclusion

It has been a challenge getting the Sierra up to the point where it's easier to build and align. NorCal members deserve much of the credit, since they supplied the feedback and field testing that pointed out the problems and opportunities. Thanks again!

NC40 to NC30 Conversion

by Ed Burke, KI7KW
28 Del Prado
Lake Oswego, OR 97035

Since I have been delighted with the performance of my Norcal40 and 40A (I have built one of each) I decided a while ago to make a Norcal30. It works just fine and I thought that I would share the changes with other enthusiasts.

The list of components refers to the schematic for the Norcal40A as it was issued by Norcal. I am not sure that Wilderness Radio has continued the same numbering system, so check with Bob Dyer if you have the latest version from them. The parts shown below are what I actually used in my 30 meter rig; you can probably make substitutions for most without any problems; for instance, where I used a silver mica cap, you can substitute a ceramic capacitor.

L1 21 turns, #26awg on FT37-67 toroid (note material).

T1 1 turn primary, 21 turns secondary, #26awg on FT37-67 toroid (note material).

C4 2.5pF (use two 5pF caps in series if 2.5pF is unavailable).

T3 20 turn primary, 4 turn secondary, #26awg on FT37-61 toroid.

C6 15pF.

C9, 10, 11, 12, 13 390pF, silver mica (this gives a 500 Hz filter bandwidth).

L4 12 turns, #24awg on FT37-61 toroid.

C14 47pF

C38 51pF, silver mica.

L6 24 turns, #26awg on T37-2 toroid.

L9 62 turns, #28awg on T68-7 toroid. You may need to adjust this slightly.

C49 47pF.

Q1 MPSH10 NPN RF transistor (optional; it probably helps a little).

X1, X2, X3, X4, X5, X6 Digikey CTX 082 crystals. Four must be matched using a simple test oscillator to 30 Hz.

L7, L8 16 turns, #24awg on T37-2 toroid.

C45, C47 200pF silver mica. 300 volt rating would be desirable.

C46 470pF silver mica, 300v also.

C31 10pF.

C35 68pF.

C18 200pF, silver mica.

This is the list of new component values. I'm surprised that it is so long. I also did the transformer output matching mod per QRPp June, 1994, as well as changing the output transistor to an MRF237 (adding a robust heat sink to that part). The result is a very nice signal just shy of 5 Watts.

My impression is that the received audio is a little "weaker" than the Norcal40A, but I'm not sure how much of that is due to the overall quieter band conditions on 30 Meters. Theoretically, there is some loss in gain due to operating closer to the gain-bandwidth product for the NE602, but the Norcal 30 is still eminently usable; I've had DX contacts with New Zealand with it, for instance.

Best of luck, 73's and enjoy!

Ed Burke KI7KW

The Green Mountain Transceiver

by Dave Benson, NN1G
80 East Robbins Ave.
Newington, CT 06111

This article describes a single-board transceiver design intended for use on any one of the HF bands. This design is merged from both the "40-40" and the earlier NN1G Mark III ('95 ARRL Handbook)

transceivers. This article describes the 20 Meter version, but operation on other bands is largely identical.

First, though, a bit of background information seems fitting. I've been contending with inquiries about the XX-40s, 30-40s, 40/30s and so on, and it seemed high time to vest the latest project with a name less subject to creative interpretation! In continuing the tradition of naming rigs after high places, I've designated this project in honor of the mountain range which runs the entire length of Vermont.

The key design feature is a heterodyne local oscillator. Although theextra complexity isn't necessary for a low-band design, it really facilitates operation on the high bands A Colpitts oscillator running in the 4.5 Mhz region is mixed with a crystal-controlled conversion oscillator and then bandpass-filtered to yield the desired 22 Mhz injection frequency. Once again, a varicap is used for tuning, this time to provide coverage of 100Khz. This increased range necessitated some form of varicap temperature stabilization, which is provided by the 1N4148 diode in the bias tuning circuitry. The remainder of the LO components were chosen for good thermal stability. The 20M version exhibited a cold-start drift of only about 10 Hzwith the tuning pot at mid-range! [In case you're curious, I considered using a 1/2-DIP CMOS oscillator IC for the conversion oscillator but cost, availability and relative spectral purity all weighed in against this scheme. This would have enabled 6M operation without requiring yet another adjustment (for overtone operation).

This design also has a number of other upgrades, so let's take a look:

* **Packaging-** The printed-circuit board version of this transceiver is a double-sided and masked affair measuring 3.5" x 5". As such, there are no on-board jumpers needed to complete the wiring. This time around, all controls and other external connections with the exception of the coax connect using 0.100" header strips and wire assemblies (provided pre-assembled in the kit version). Why? It looks much neater and oh by the way-it's much easier to troubleshoot if the transceiver disassembles easily.

* **Better Crystal filtering-** A glance at the schematic reveals that the IF filter's been upgraded to the 4-crystal version. The IF frequency is 8.00Mhz, which will support operation even on 6M with adequate image rejection.Adjacent-sideband rejection was measured at -40 dB, a noticeable improvement over the 30-40 performance. Filter loss is 5dB, an improvement over the lossy 30-40 performance, and bandwidth is approximately 800 Hz . Receiver MDS is approximately -125 dBm.

* **Improved front-end filtering.** The receiver front end circuitry has additional filtering to improve image rejection. The "30-40" in particular was marginal in this regard. There's a double-tuned circuit this time, and the T-R switch design reverts to the W7EL series L-C to provide additional bandpass filtering. I can hear you saying- "I hate winding toroids!- Why didn't you use IF transformers like in the NN1G design?"] I didn't want the filter design constrained by the IF transformer characteristics. By using toroids, there's more leeway in setting filter values to suit each band. As I came down to the wire for publication, my signal generator is out for calibration, so I'm currently unable to provide measured values for imagerejection.

* **RIT-** You asked for it, you got it! Although I rarely use a RIT control, it's a must for many folks. The circuit is a derivative of the RIT upgradewhich appeared in the pages of 72 a while back. The polarity on the On/Offcontrol has been reversed with respect to that earlier version to allow the use of a control pot with an integral On/Off switch (isn't hindsight wonderful?). If you're using the printed-circuit board version of this design, the RIT pot/switch are connected through a 4-pin

header. If you don't plan to use the RIT feature, this header may be left unused and RIT will be inactivated.

* **TX drive-** The TX drive chain has been beefed up to provide more gain and improved stability. The transmit bandpass filter has a MMIC imbedded in it(see the July '95 issue of 72). In addition to the improved gain, the placement of the gain block in this location loads the filter, which aids stability by keeping the impedances reasonable. This pays off in a tuneup procedure free from unwanted anomalies (i.e, jumps in output level and othersigns of instability). Although the use of a MMIC is overkill in this application, they're small- this is a nice way of saying the darned thing fit! In practice, I'm able to adjust the drive to provide output levels ranging from 0.5W to the full rated power.

* **TX power-** Thanks to the improved drive, there's more output power available. You should see 2.5-3 watts on any of the bands, and the output harmonic filter has been designed for this level. For the 20M version, at full power the 2nd harmonic is down 34 dB. Spurious outputs were down about50 dB.

* **The Joy of Big Audio.** The various op amp and LM386 audio finals have been replaced with the 8-pin version of the LM380. Although this device draws a bit more idling current than its little brothers, it's worth it in terms of audio quality, and on a good signal will easily annoy other family members! Idling current on the transceiver as a whole is approximately 35 mA, still a battery-friendly value for the portable crowd. I did tinker with audio-derived AGC but was never happy with the result. I've left this feature off and provided a tie-point (W1) at pin 5 of the IF Amp for those folks determined to experiment with this function.

20-Meter parts values not shown on the schematic are as follows:

C31,33: omit- not used
Q1: MPF102
Q2-Q5: 2N2222A metal
Q6: 2N3906
Q7: 2SC799 or 2N3553
U1,4,6,7: NE602AN
U2: MC1350P
U5: 78L08
U8: MAR-3
U9: CD4066
D1: MV1662
D2-D8: 1N4148L1,
L1: T37-6, 14T (0.59 uH)
L3: T37-6, 26T (2.0 uH)
L4, L5: T37-6, 17T (0.87 uH)
L6,L7: T37-6, 15T (0.68 uH)
L8: FT37-61, 11T (6.8 uH)
L9: T37-6, 11t (0.36 uH)
L10: T37-6, 13t (0.50 uH)
L11: T37-2, 27 turns (3.3 uH)
T1: 10.7 Mhz IF xfrmr (Mouser 42IF123)
T2: FT37-43, 4 turns bifilar.

If you're interested in the kit version of this transceiver, it includes thehigh-quality board, all on-board parts and interconnect assemblies for the external controls. As with the 40-40 series, there's a honest-to-goodness intruction manual. The price is $72 postpaid. The GM-20 and its 30 and 15-meter brothers are currently available. Additional bands will be added shortly as based on popular demand. See you on the high bands!

To order the Green Mountain Transceiver send a check or money order for $72 to: Small Wonder Labs
80 East Robbins Ave.
Newington, CT 06111

Please specify the band that you wish to order.

72, Dave, NN1G

[Note: this article first appeared in "72" the journal of the New England QRP Club. It was updated by Dave and is reprinted with permission from "72". Thank you to Dave and "72" for allowing us to reprint the article. Schematics can be found in the center foldout section. Doug, KI6DS]

The St. Louis Tuner

NorCal is now taking orders for the St. Louis Tuner which will be delivered in the Spring of 1996

The NorCal QRP Club along with the St. Louis QRP Club are pleased to announce that the St. Louis Tuner is now available. The tuner is a T-match, with dual meters for continuous display of forward and reflected power. It contains a SWR bridge that is a combination of the Lewallyn and Stocton circuits. The tuner also has a 10Watt dummy load, balun, and has the following connectors: SO239, BNC, RCA Plug, 5 Way Jack for both incoming and outgoing signals. The capacitors are custom made dual section air variables with a quarter inch shaft. (Not the plastic AM tuning ones used in the prototype.) The front section has 140pF and the back section has 91 pF. Cost of the complete kit, which contains pcboard, all components, wire, Case (matches the Sierra and Cascade), Knobs and switches is $75 US Funds only. Postage is $5 in the US, $10 Canada and $15 DX. California residents please add $5.44 sales tax. California residents send $85.44, all other US residents send $80, Canadian members send $85 and DX members $90, all in US Funds only!!! Make checks or money orders out to: Jim Cates, NOT NorCal or QRPp. We are only kitting 250 of these, so order quickly if you are interested. Send your orders to:

Jim Cates
3241 Eastwood Rd.
Sacramento, CA ~~95841~~
95821

Cascades

We have 50 Cascade kits left. The price is $199 plus $5 shipping in the US, $10 to Canada, and $15 to DX addresses. This is absolutely the last of the kits and when they are gone, there will be no more. Send your orders to Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95841. California residents please include $14.43 sales tax. To order a Cascade 20/75M SSB transceiver: Ca. Residents send $218.43, US Residents send $204, Canadian Residents send $209, and DX addresses send $214. All orders must be in US FUNDS only. Kits will be shipped in the spring. Make checks and money orders to Jim Cates, NOT NorCal.

Back Issues of QRPp

Back issues of QRPp are available in bound issues only. Volume I contains the 3 issues from 1993, Volume II contains the 4 issues from 1994, and Volume III has the 4 issues from 1995. Volume I is 140 pages and is $10 plus $2 shipping for US addresses, $5 DX. Volume II is 296 pages and is $15 plus $2 shipping for US addresses, $5 DX. Volume III is 276 pages and is $15 plus $2 shipping for US addresses, $5 DX. If you order all 3 volumes the cost is $40 plus $3 shipping for US addresses, $10 DX. To order send your money to Doug Hendricks, 862 Frank Ave., Dos Palos, CA 93620. Make all checks and money orders out to Doug Hendricks and not to NorCal or QRPp. All prices are for US funds only.

Curtis 8044ABM Keyer Chip and Far Circuits Board Combo

NorCal has made a bulk purchase of the Curtis 8044ABM Keyer Chip and isoffering it with the Far Circuits Board and the Info Sheet for $17.00 postpaid. DX orders add $5 shipping. US Funds only! Make Checks or money orders out to Jim Cates, NOT NorCal. Send your orders to: Jim Cates, WA6GER, 3241 Eastwood Rd., Sacramento, CA 95821.

7.040MHz Crystals

We have located a supply of 7.040MHz crystals in the small HC49 holders. These are on the QRP calling frequency for 40 Meter CW. The price is $3 each, or 4 for $10, postage paid. Make Checks or money orders out to Doug Hendricks, NOT NorCal. Send to: Doug Hendricks, 862 Frank Ave., Dos Palos, CA 93620.

NorCal QRP Club

QRPp is published at Dos Palos, California 4 times per year: March, June, September, and December. Subscription fee is $10 per year for US residents, $15 for Canada, and $20 per year for DX. To join NorCal QRP Club send your name, call, and address to Jim Cates. There is no charge for membership to NorCal QRP Club. To receive QRPp, you must subscribe and pay the fees. Send your money (US Funds ONLY) to:

Jim Cates, WA6GER
3241 Eastwood Rd.
Sacramento, CA 95821

Make Checks or money orders out to Jim Cates, do not make them out to NorCal!! The articles in this journal have not been tested nor is there any warranty as to the feasibility of the items described.

QRPp, Journal of the NorCal QRP Club
862 Frank Ave.
Dos Palos, CA 93620

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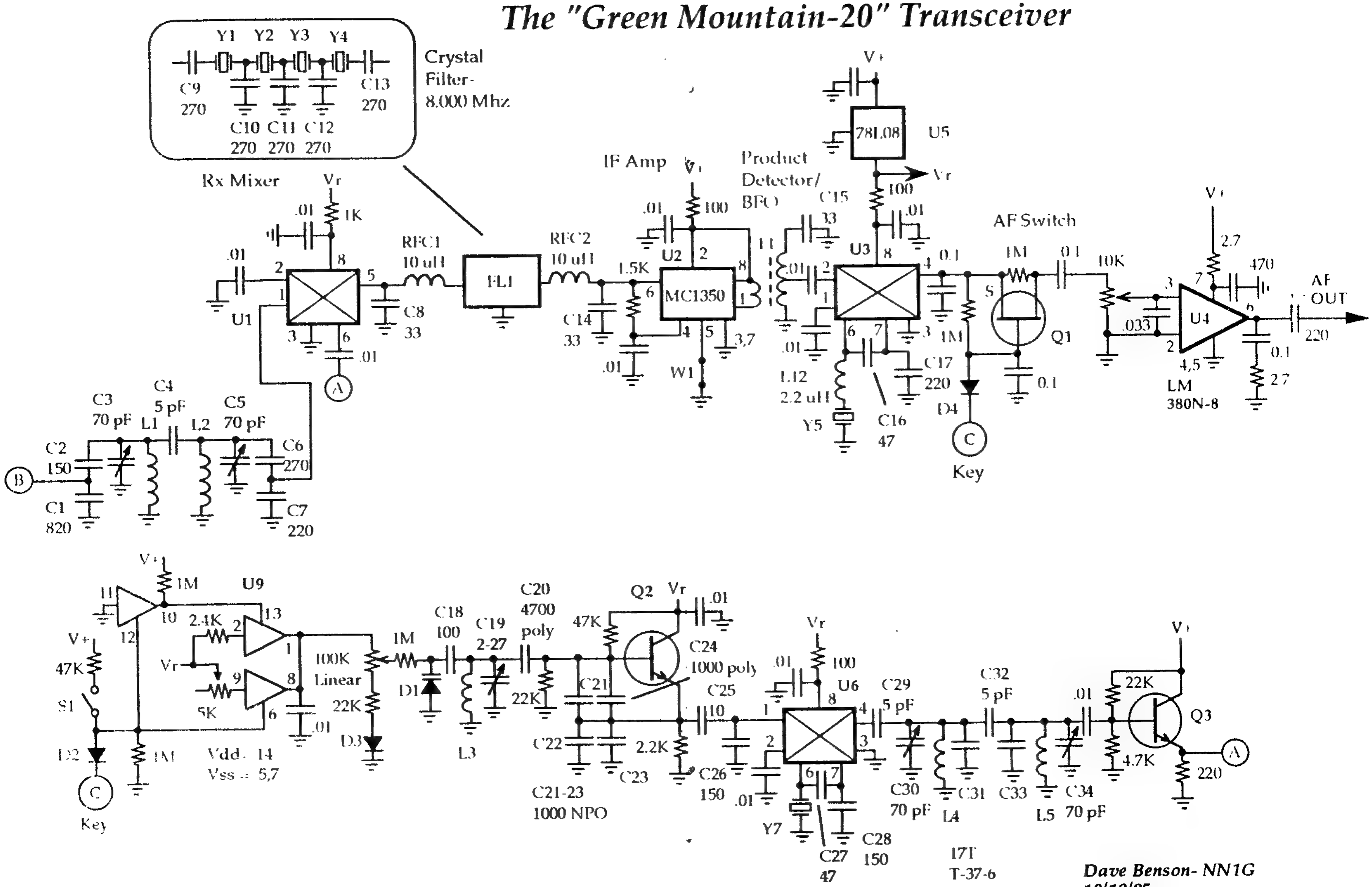
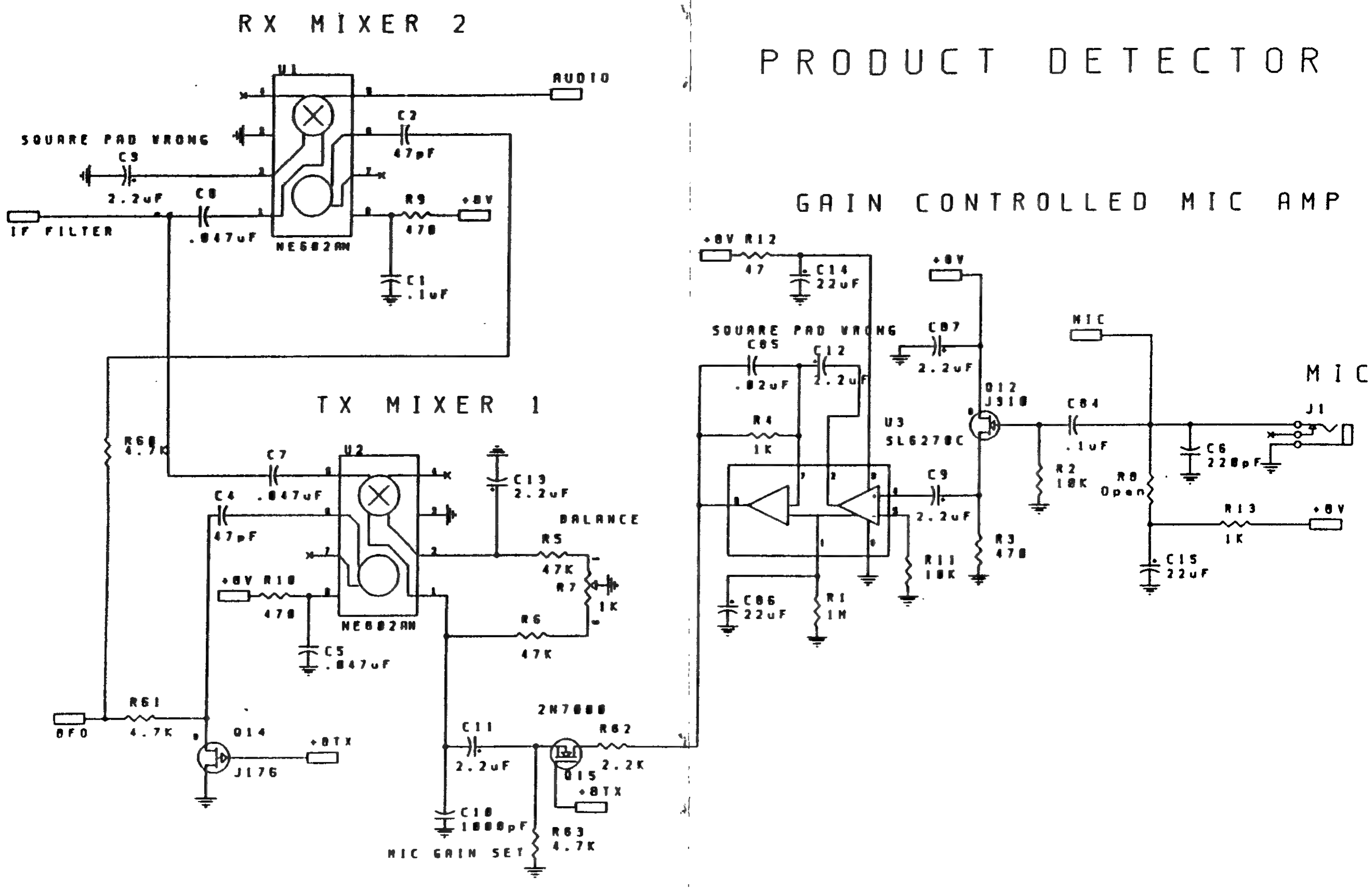
The "Green Mountain-20" Transceiver



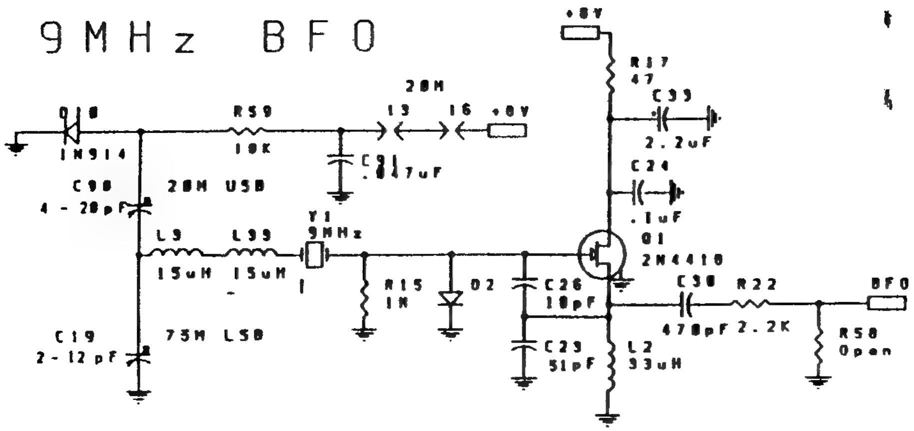
Dave Benson- NN1G
10/19/95

QRPp Dec. 95

PRODUCT DETECTOR

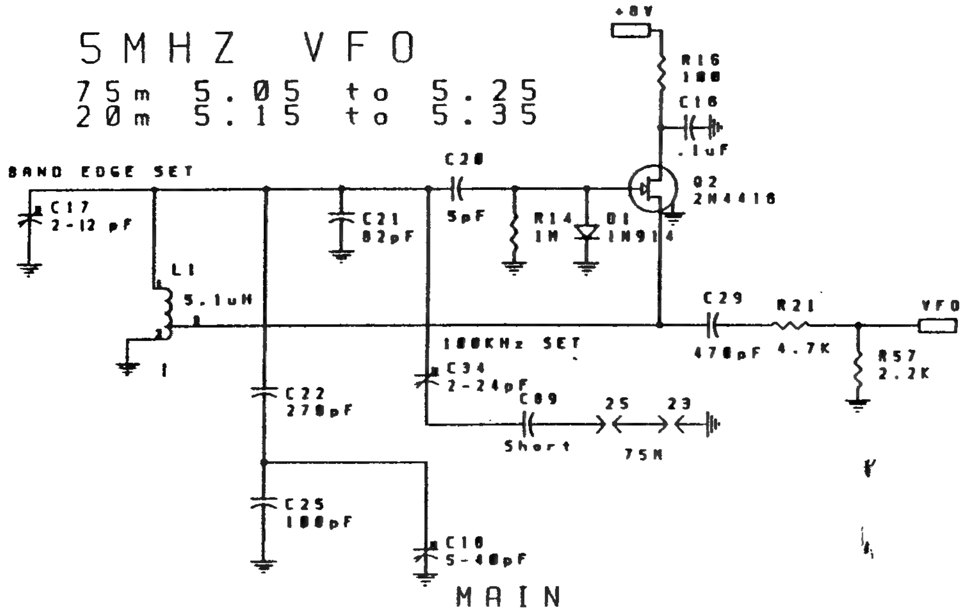


9MHz BFO

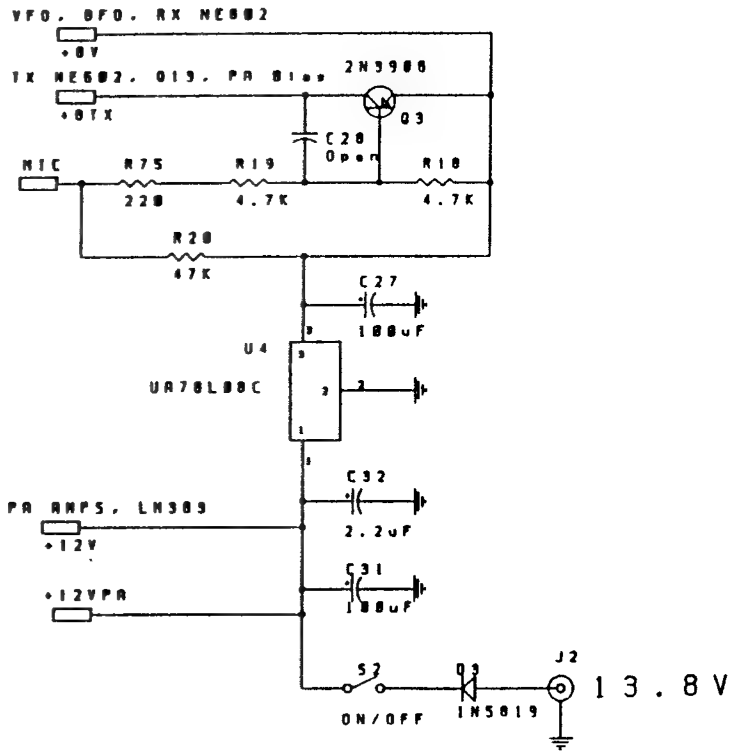


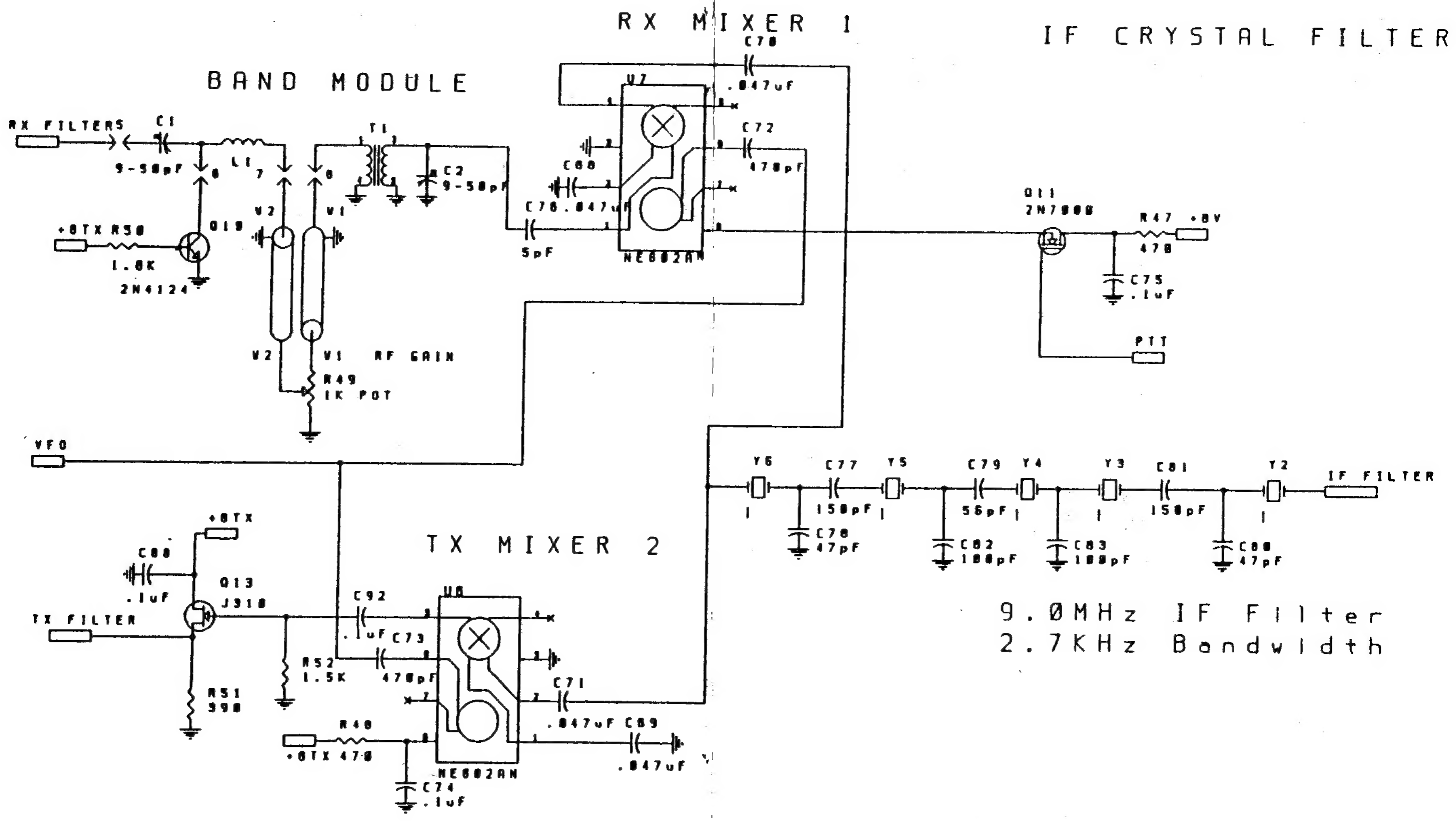
5MHZ VFO

75m 5.05 to 5.25
20m 5.15 to 5.35

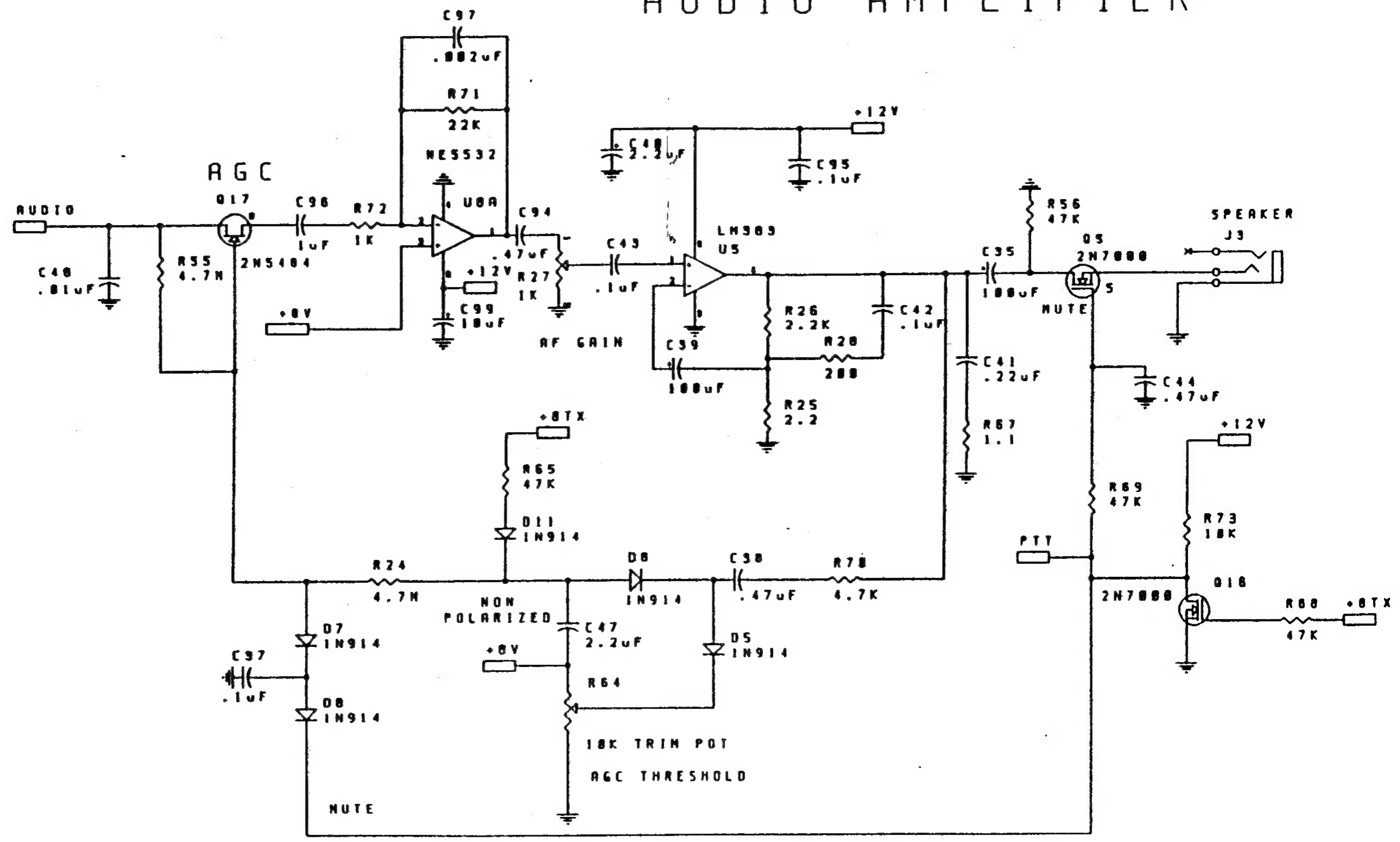


VFO, BFO

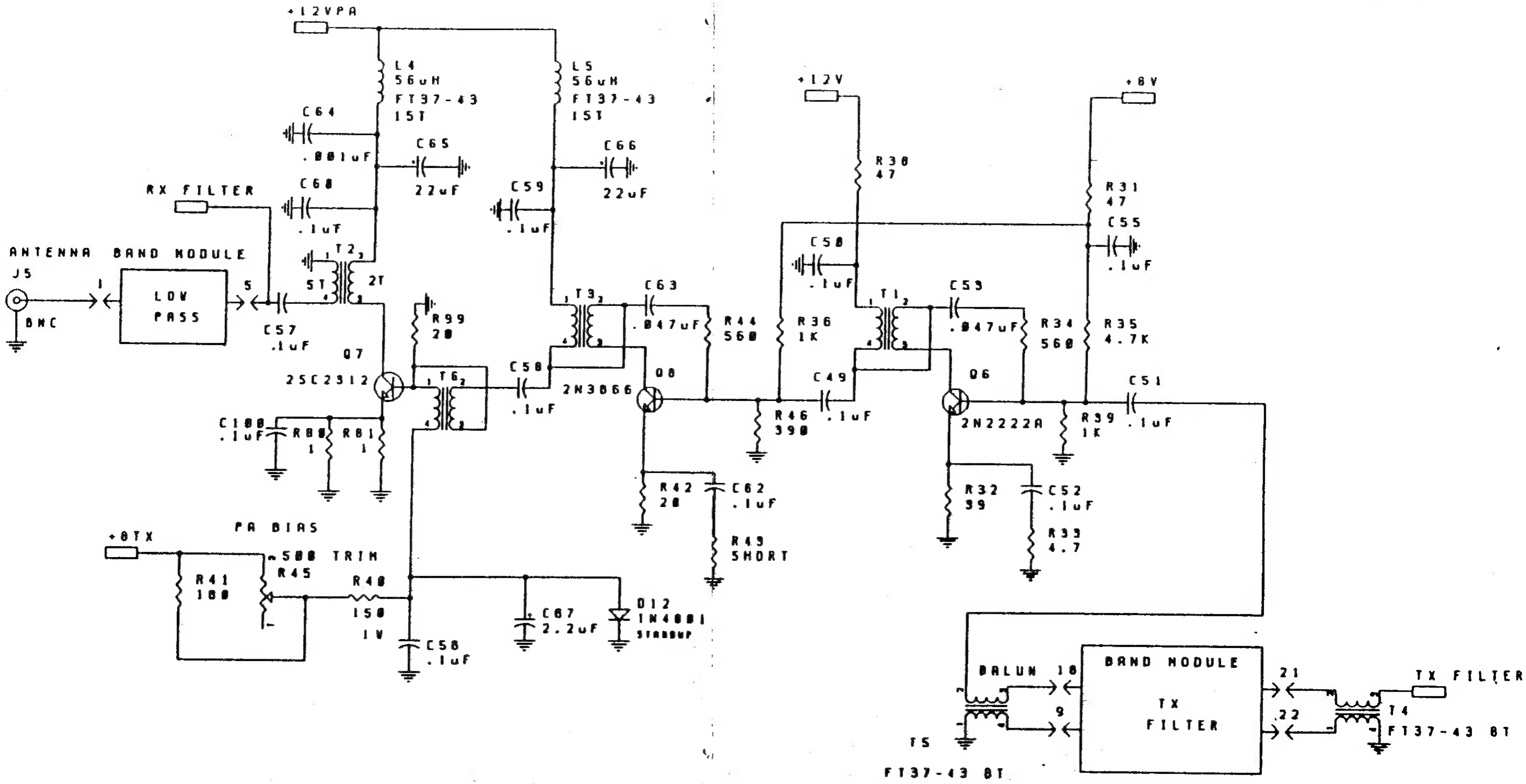



BAND MODULE
RX MIXER 1
IF CRYSTAL FILTER
TX MIXER 2
RX FILTERS
C1
9-50pF
L1
Q19
2N4124
+8TX R50
1.8K
V2
V1
RF GAIN
R49
1K POT
T1
C2
9-50pF
C76 .047uF
5pF
C68
U7
NE602AN
C70
.047uF
C72
470pF
Q11
2N7000
R47 +8V
470
C75
.1uF
PTT
VFO
+8TX
C88
.1uF
Q13
J310
TX FILTER
R51
390
C92
.1uF
C73
470pF
R52
1.5K
U8
NE602AN
R48
+8TX 470
C74
.1uF
C71
.047uF
C69
.047uF
Y6
C77
150pF
C78
47pF
Y5
C79
56pF
C82
100pF
Y4
Y3
C83
100pF
C81
150pF
C80
47pF
Y2
IF FILTER
9.0MHz IF Filter
2.7KHz Bandwidth

AUDIO AMPLIFIER

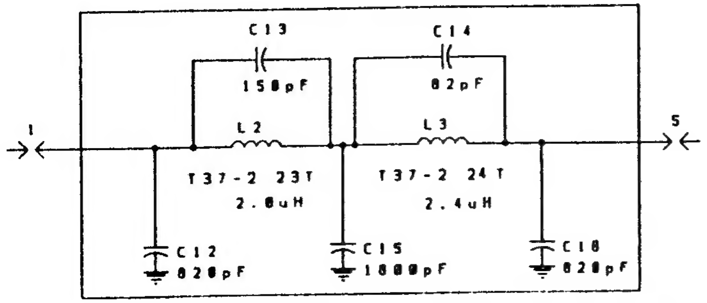


POWER AMPLIFIER

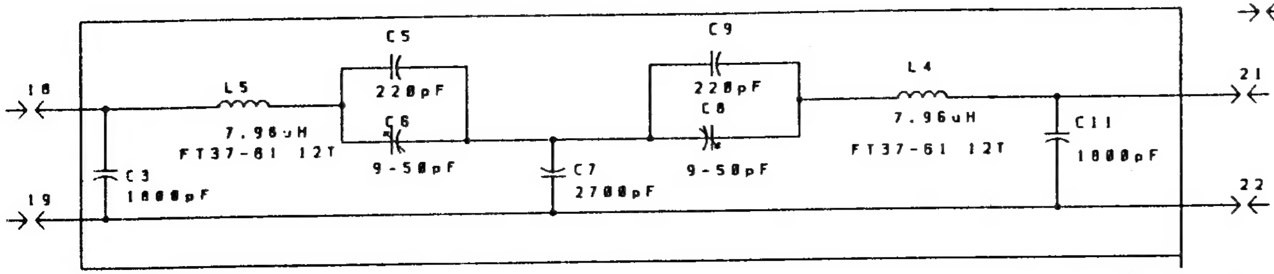


75m BAND MODULE

75m LOW PASS



75m TX FILTER



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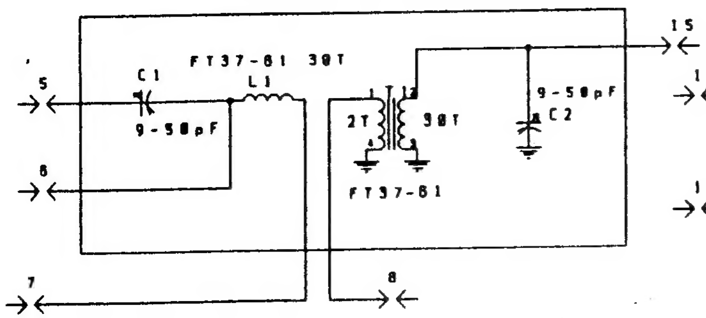
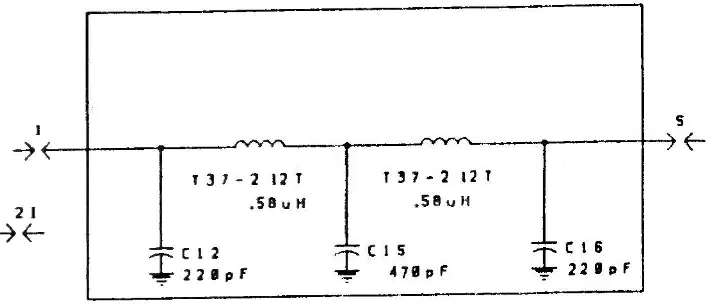
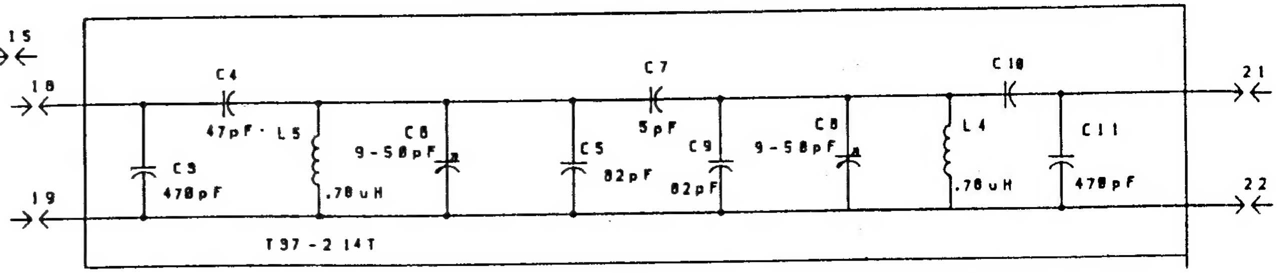


20 M BAND MODULE

20 M LOW PASS



20 M TX FILTER



20 M RX FILTER